



# **Public Meeting on Possible Regulatory Process Improvements for Advanced Reactor Designs**

June 27, 2019

Telephone Bridge: (888) 831-4309  
Passcode: 4816955



# Public Meeting

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- Telephone Bridge  
888-831-4309  
Passcode: 4816955
- Opportunities for public comments and questions at designated times

# Outline

- ❑ Opening Remarks
- ❑ Technology Inclusive Content Applications Project (TICAP)
- ❑ Siting Guidance
- ❑ Using GEIS In Support of the Construction and Operation of Advanced Nuclear Reactors
- ❑ Consensus Codes and Standards Survey
- ❑ Environmental topics
  - ❑ Interim Staff Guidance for Micro-Reactors Environmental Reviews
  - ❑ NEI white paper Streamlining Environmental Reviews
- ❑ Micro-Reactors
  - ❑ Overview
  - ❑ Task Force High Priorities
- ❑ Endorsement and Gap Analysis of ASME/ANS RA-S-1.4
- ❑ Pre-application Interactions with the NRC
- ❑ Division 5 Endorsement Kick-off
  - ❑ ASME QME-1 for High Temperature Material Qualification for Functional Capability
- Open Discussion
- Closing Remarks

# Technology Inclusive Content of Applications Project (TICAP)

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- Technology Inclusive Content of Application Project (TICAP)
  - Amir Afzali, Southern Company Services
- Technology Inclusive Content of Applications
  - William Reckley, NRC

# Siting Guidance

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- Population-Related Siting Considerations for Advanced Reactors
  - W. Reckley, NRC

- Using GEIS In Support of the Construction and Operation of Advanced Nuclear Reactors
  - Rich Powell, Clearpath
  - Jeffrey Merrifield, Clearpath

# Break

*Meeting/Webinar will begin shortly*

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- Codes and Standards for Advanced Reactors
  - Mike Tschiltz, NEI



# Environmental Topics

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- [Interim Staff Guidance for Micro-Reactors Environmental Reviews](#)

Mallecia Sutton, NRC

- NEI White Paper Streamlining Environmental Reviews

Kati Austgen, NEI

# Lunch

*Meeting/Webinar will begin shortly*

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- [NRC Perspectives on Micro-Reactors Licensing](#)
  - Boyce Travis, NRC
- [Micro-Reactors Regulatory Topics](#)
  - Marc Nichol, NEI

- Endorsement and Gap Analysis of ASME/ANS RA-S-1.4 “PRA Standard for Advanced Non-LWR Nuclear Power Plants”
  - Mary Drouin, NRC
  - Hanh Phan, NRC

- Preparing for Advanced Reactor Reviews:  
Pre-Application Interactions  
– Steve Lynch, NRC

# Break

*Meeting/Webinar will begin shortly*

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# Division 5 Endorsement Kick-off

- NRC Review and Endorsement of ASME BPVC Section III, Division 5
  - ASME QME-1 and Advanced Reactor Material Qualification for Functional Capability
  - Andrew Yeshnik, NRC

# Future Meetings

## 2019 Tentative Schedule for Periodic Stakeholder Meetings

August 15

October 10

December 11



# Open Discussion and Closing

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# Technology Inclusive Content of Application Project (TICAP)

Amir Afzali  
Southern Company Services

NRC Stakeholder Briefing  
June 27, 2019

# Background

- The NRC and industry seek thorough, efficient and consistent review and approval of license applications
- Historically the NRC Staff has sought to provide a consistent and thorough review of the current applications using the LWR Edition of its Standard Review Plan (SRP). Use of this kind of mutually agreed-upon “up-front” guidance helps
  1. ensure that the applicant's assumptions are technically correct and acceptable to the NRC and
  2. demonstrate that the proposed activities will not adversely affect public health and safety or the environment
- The current content of application has been progressively developed largely based on predecessor reviews and familiarity with the designs that have been submitted to the NRC for over 40 years
- Due to the nature of the advanced non-LWR designs, which promise enhanced safety margins through use of alternate fuels and coolants and different approaches to radionuclide retention resulting in fundamentally different risk profiles, there is a significant benefit to developing a more robust and technology-inclusive content of application guidance that facilitates efficient, thorough, and consistent application review. This modernized process will have the following attributes:
  - Versatile - The variance in technologies and designs requires robust application content that is versatile enough to be used by most if not all potential applicants
  - Systematic - It facilitates thorough and consistent safety assessments for different designs across and within different technologies
  - Compatible - It correlates to the underlying safety intent of the current light-water centric content of application, thereby demonstrating consistency with the Commission’s mission of protecting public safety

# Proposed TICAP

- **Scope:**
  - **Optional approach** to develop portions of the Safety Analysis Report
  - **Builds on NEI 18-04 guidance:** Licensing Modernization Project's (LMP's) approach for selecting Licensing Basis Events (LBEs), classification of Structures, Systems, and Components (SSCs), and Defense-in-Depth (DiD) adequacy determination.
- **Project and Execution Structure:**
  - Cost-Share Structure - 80-20 cost-share project with Department Of Energy (DOE)
  - Primary DOE contractor, Southern Company Services
  - Coordination = Through NEI Advanced Reactor Regulatory Taskforce
  - Project Team:
    - Steve Nesbit (Former Duke Director)
    - Frank Akstulewicz (Former NRC and Commissioner Staff)
    - Alan Levin (Former NRC, Commissioner, and DOE Staff)
    - Southern Nuclear Development
    - Developers: (GE, Westinghouse, Kairos, Oklo)
  - Executive Advisory Group- Former Commissioners (Honorable Dr. George Apostolakis, Honorable Jeffery Merrifield, and Honorable Dr. Richard Meserve, former Chairman of the U.S. Nuclear Regulatory Commission)
  - Collaboration Method – Similar to LMP, extensive collaboration with the NRC is expected
  - Proposed Product: NEI guidance document for Technology- Inclusive Content of Applications for non-LWRs to the NRC for endorsement by 1<sup>st</sup> quarter of 2021 with expected endorsement by the first quarter of 2022
  - Project start time - Kickoff meeting is preliminarily scheduled for mid-July
  - First deliverable is an annotated outline for the final product by the end of fiscal year 2019 (end of Sept 2019)

# Key Attributes of TICAP

- **Key Benefits:**

- Major step towards industry goal for having safety focused reviews which minimize the burden of generating and supplying non-safety significant information
- NRC & “Industry” (developers and utilities) objective to come to a common understanding of how to implement adequate protection for non-LWRs
- Supports timely and effective implementation of the [Nuclear Energy Innovation and Modernization Act](#) requirements for NRC to increase the use of risk-informed, performance-based licensing evaluation techniques
- Advancing DOE’s recent successes in collaborating with industry and NRC to establish a clearly described regulatory framework for non-LWRs
- Providing developers with flexibility to make best choices, from the safety and commercial viability points of view, for their designs



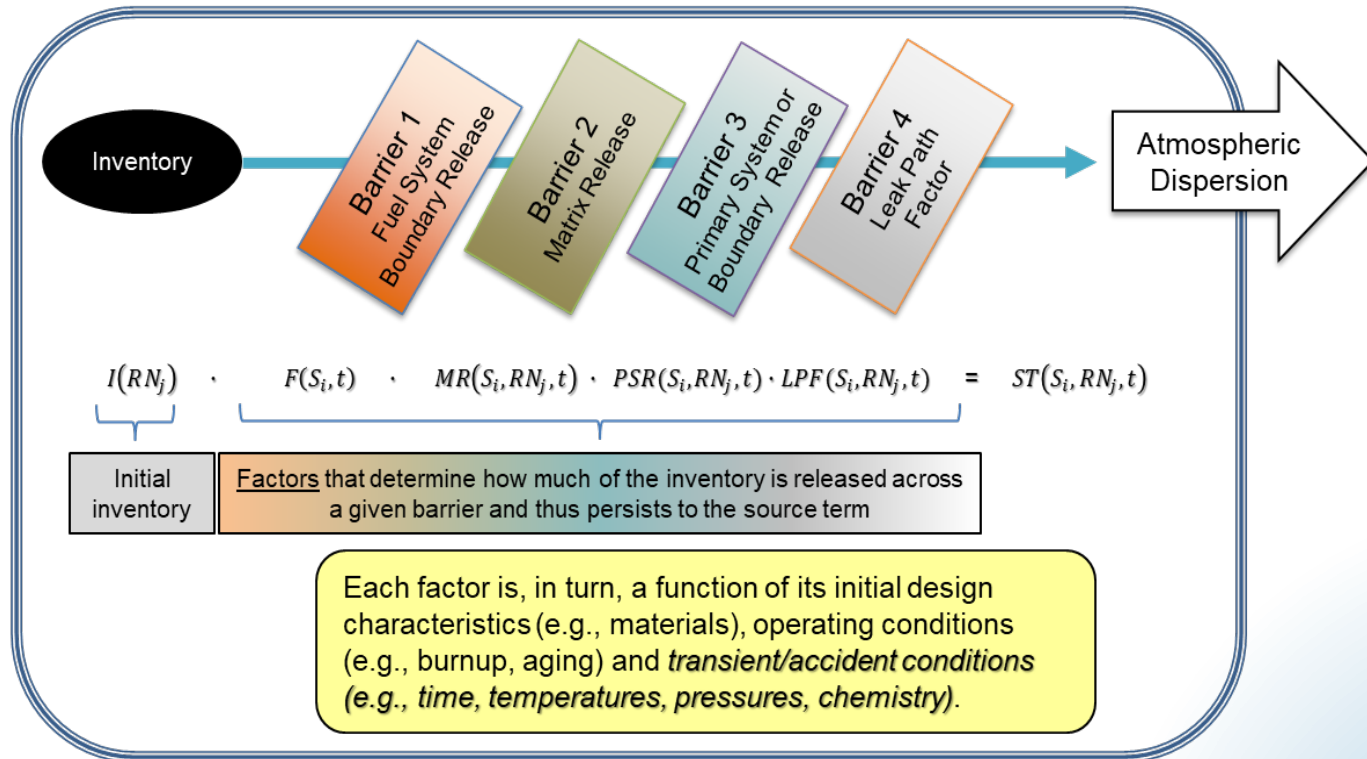
# Technology Inclusive Content of Applications

June 27, 2019

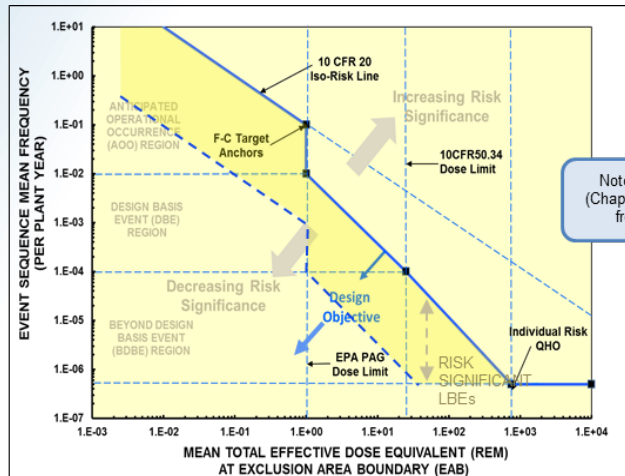


# Return to first principles

Recent NRC activities related to advanced reactors (e.g., functional containment performance criteria, possible changes to emergency planning & security, and DG-1353) recognize the limitations of existing LWR-related guidance, which requires a return to first principles such as fundamental safety functions supporting the retention of radionuclides

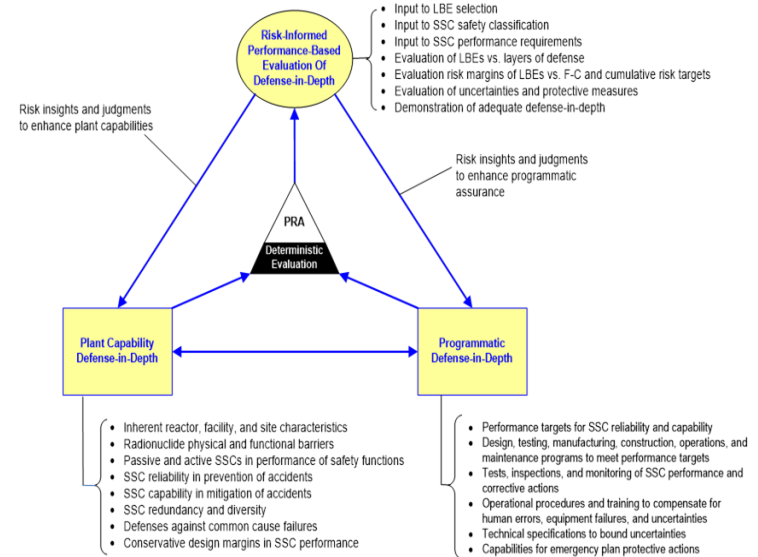


# Informing Licensing Basis



Note that DBAs (Chapter 15) derived from DBEs

- F-C Target considered along with cumulative risk metrics, safety classification, and assessment of defense in depth



## Draft Regulatory Guide 1353

*“Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology To Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light Water Reactors”*

[www.regulations.gov](http://www.regulations.gov)

Docket: NRC-2019-0113; Comment Period to July 2, 2019



# Content of Applications

- NEI 18-04 provides useful guidance for applicants to identify and provide the appropriate level of information
- Combination of deterministic evaluations and probabilistic risk assessments
- Information needed on fuel, primary, and other barriers to define limitations, performance characteristics, and as input to mechanistic source term
- Information needed on SSCs and programmatic controls associated with key safety functions
- Scope and depth for other information (e.g., ancillary plant systems) to be determined based safety/risk significance (i.e., roles in preventing or mitigating licensing basis events)
- Level of detail can also reflect potential performance-based approaches (see Introduction, Part 2, to NUREG 0800)

*Content of Applications  
Discussion*



# Population-Related Siting Considerations for Advanced Reactors

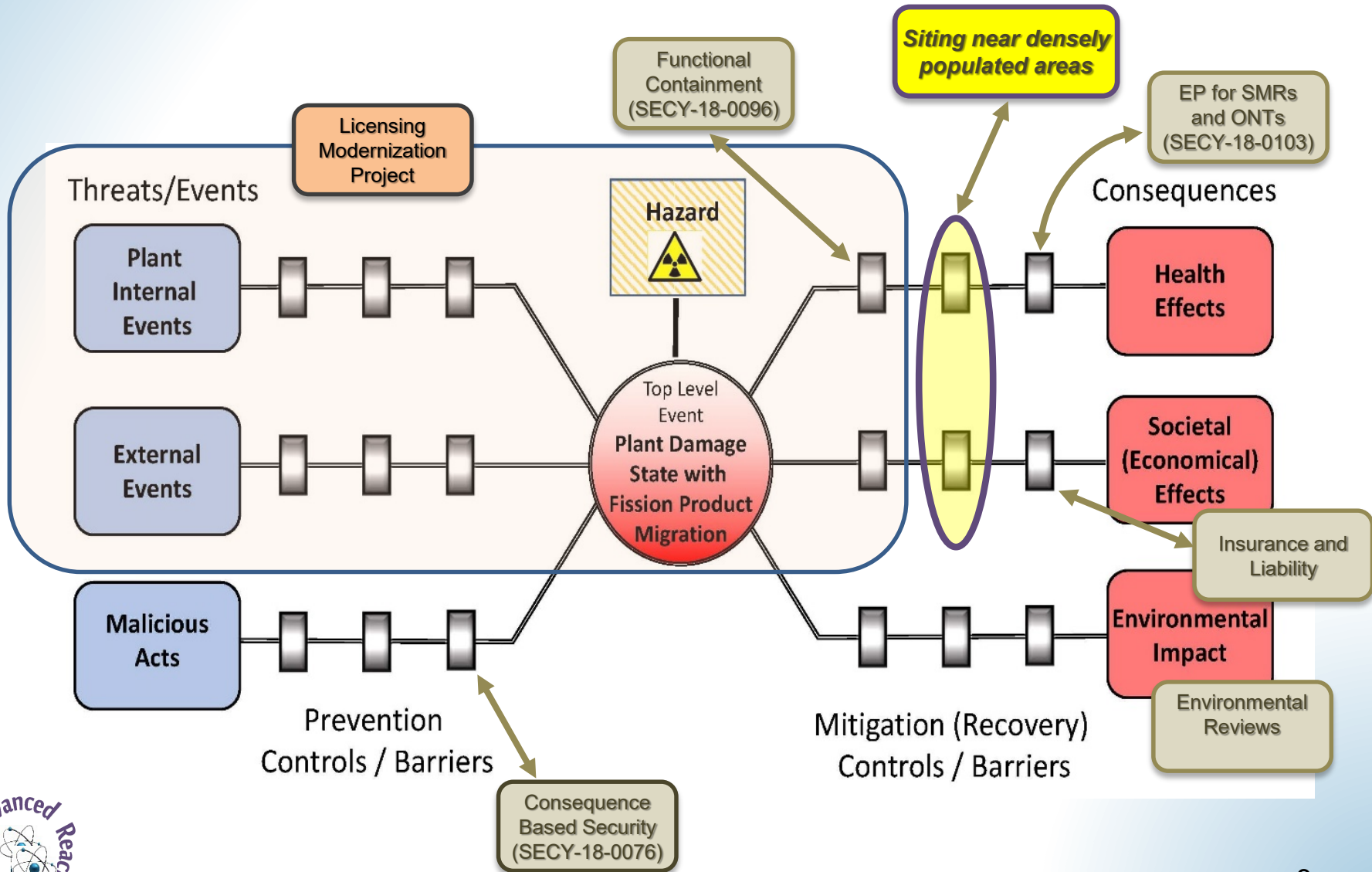
June 27, 2019



# Siting Discussions

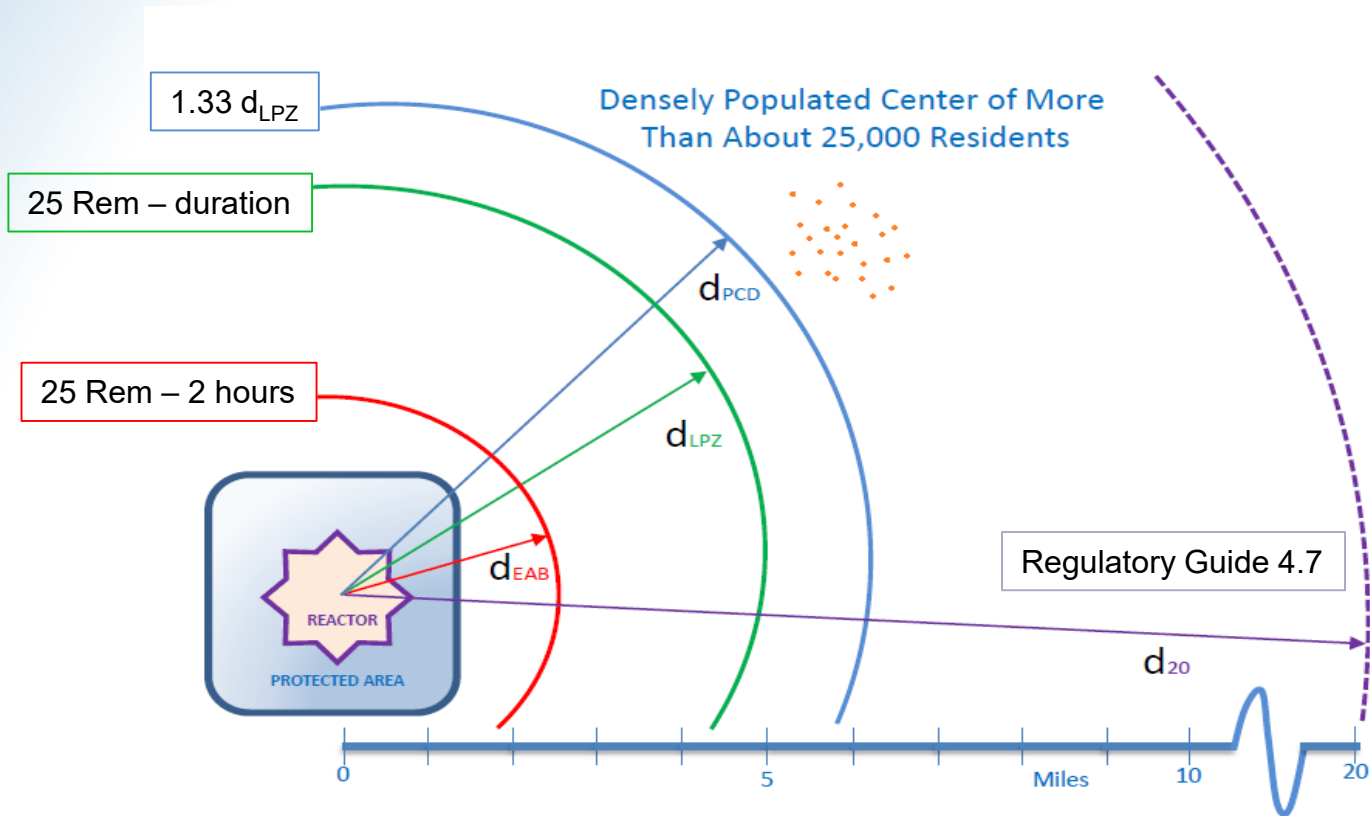
- Background
- Longstanding Policy Issue
- Discussed in previous stakeholder meetings
  - December 14, 2017 (ML17354B219)
    - White Paper (ML17333B158)
  - May 3, 2018 (ML18130A688)
  - March 28, 2019 (ML19108A104)
  - ***White Paper (ML19163A168)***
  - ***June 27, 2019 stakeholder meeting***
- August 2019 – ACRS Subcommittee Meeting

# Integrated Approach



- Background
  - Regulatory Guide (RG) 4.7, “General Site Suitability Criteria for Nuclear Power Stations”
  - SECY-16-0012, “Accident Source Terms and Siting for Small Modular Reactors and Non-Light Water Reactors” (February 7, 2016; ML15309A319)
- Discussion
  - Option 1 (status quo)
  - Option 2 (source term factor)
  - Option 3 (offsite dose calculation)
  - Option 4 (develop societal risk measure)

# Background



- $d_{EAB}$  – radial distance to the exclusion area boundary (EAB)
- $d_{LPZ}$  – radial distance to the outer boundary of the low population zone (LPZ)
- $d_{PCD}$  – population center distance (PCD) to the nearest boundary of a densely populated center
- $d_{20}$  – 20 mile outward radial distance (population density of  $\leq 500$  persons per square mile – RG 4.7)

# Option 1 (Status Quo)

## Advantages

- Save resources by deferring case-by-case assessments until there is increased certainty of applications

## Disadvantages

- Case-by-case assessments do not reduce regulatory uncertainties
- Funding for advanced reactor activities available

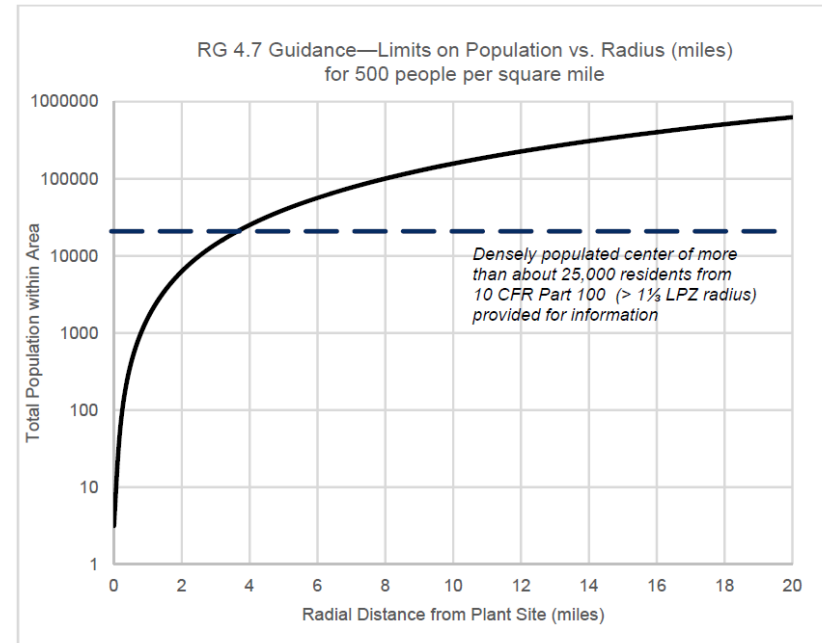


Figure 2 RG 4.7 limits on total population versus radius

Distance (m)	Total Population
1	1,571
2	6,283
4	25,132
5	39,270
10	157,078
15	353,426
20	628,312

# Option 2 (Source Term Factor)

$$SR = \pi r^2 \times D \times \text{ppsm}$$

where:

$r$  is the radial distance from a reactor site  
 $D$  is a factor representing the source term or radioactive material released from a facility

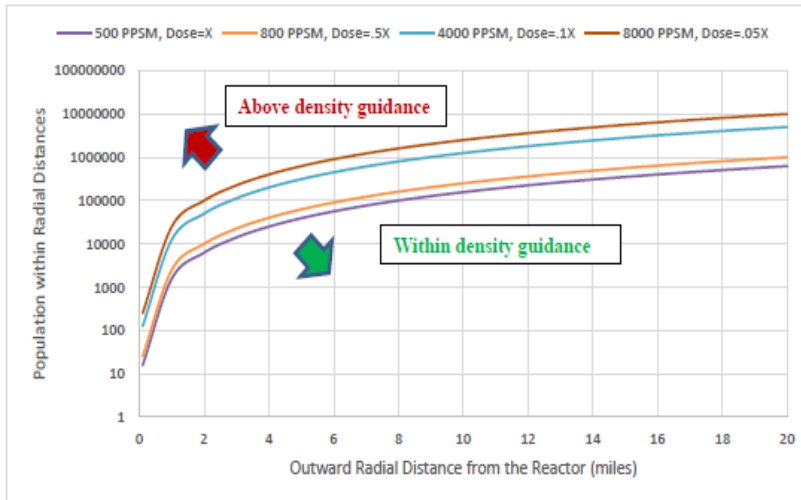


Figure 5. Population density comparison.

Table 1. Population density calculation results

Source term	×	0.5×	0.1×	0.05×		
Radius (miles)	20	14.1	6.3	4.5		
25% margin (miles)		15.8	7.1	5		
Miles	Pop. density:		500	800	4,000	8,000
	Area	Population				
0.1	0.03	16	25	126	251	
1	3.1	1,571	2,513	12,566	25,133	
2	12.6	6,283	10,053	50,265	100,531	
3	28.3	14,137	22,619	113,097	226,195	
4	50.3	25,133	40,212	201,062	402,124	
5	78.5	39,270	62,832	314,159	628,319	
6	113.1	56,549	90,478	452,389	904,779	
7	153.9	76,969	123,150	615,752	1,231,504	
8	201.1	100,531	160,850	804,248	1,608,495	
9	254.5	127,235	203,575	1,017,876	2,035,752	
10	314.2	157,080	251,327	1,256,637	2,513,274	
11	380.1	190,066	304,106	1,520,531	3,041,062	
12	452.4	226,195	361,911	1,809,557	3,619,115	
13	530.9	265,465	424,743	2,123,717	4,247,433	
14	615.7	307,876	492,602	2,463,009	4,926,017	
15	706.9	353,429	565,487	2,827,433	5,654,867	
16	804.2	402,124	643,398	3,216,991	6,433,982	
17	907.9	453,960	726,336	3,631,681	7,263,362	
18	1,017.9	508,938	814,301	4,071,504	8,143,008	
19	1,134.1	567,057	907,292	4,536,460	9,072,920	
20	1,256.6	628,319	1,005,310	5,026,548	10,053,096	



# Option 2 (Source Term Factor)

## Advantages

- Supports the policy on siting plants away from population centers and introduces a variable criterion based on source term or power level
- Variable criterion is based on a general relationship between possible radiological releases and the inventory of radionuclides (e.g., power level) while otherwise maintaining the independence between siting and design
- Promotes regulatory stability and predictability by replacing single prescriptive criterion with technology-inclusive guidance based on general, high-level relationships

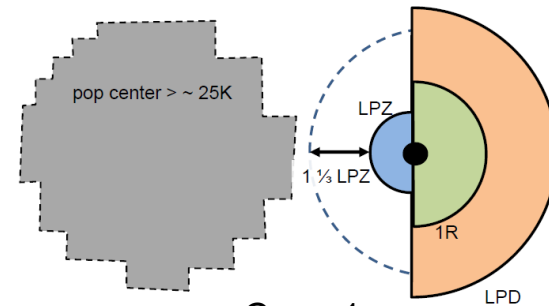
## Disadvantages

- Requires expending resources (remedied somewhat by budget appropriations)
- Possible negative perceptions of reducing practice of site approvals being independent of reactor designs

# Option 3 (Offsite Dose Calculation)

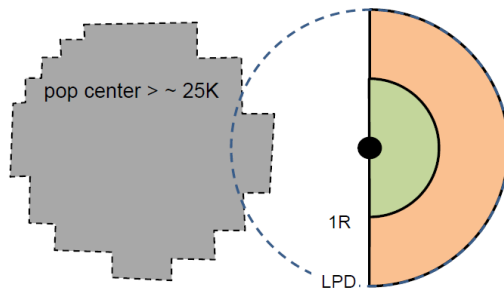
For plants with event sequence doses > 1 rem beyond the site boundary (DBEs and BDBEs as defined in DG-1353), population density < 500 persons per square mile over the radial distance equal to twice the radius of the at which 1 rem is estimated

LPZ – Event Sequences with Offsite Doses > 25R  
 LPD – Event Sequences with Offsite Doses > 1R



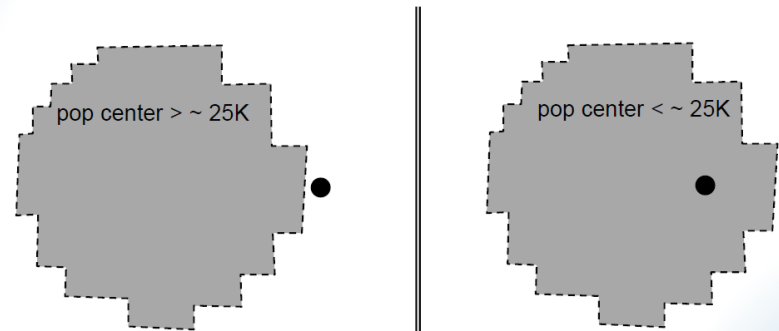
Case 1

No LPZ – No Event Sequences with Offsite Doses > 25R  
 LPD – Event Sequences with Offsite Doses > 1R



Case 2

No LPZ – No Event Sequences with Offsite Doses > 25R  
 No LPD – No Event Sequences with Offsite Doses > 1R



Case 3

# Option 3 (Offsite Dose Calculation)

## Advantages

- Allows consideration of the design- and site-specific accident consequences and specific features of an advanced reactor design that may limit the release of radionuclides beyond the likely lesser power levels.
- Promotes regulatory stability and predictability by replacing single prescriptive criterion with technology-inclusive, performance-based approach

## Disadvantages

- Requires expending resources (remedied somewhat by budget appropriations)
- Possible negative perceptions of reducing practice of site approvals being independent of reactor designs

## Option 4 (Societal Risk Measures)

- Develop societal risk measures for assessing specific advanced reactor designs at specific sites
- Consider factors beyond the potential dose to individuals and populations, including matters such as adverse effects on economies, land availability, population displacement, and decontamination costs.

### Advantages

- Arguably the best assessment of the societal risks associated with a specific reactor design located on a specific site for comparison to other societal risks or performance measures.

### Disadvantages

- Significant resources and time to develop
- Significant change from considering siting as an independent element of defense in depth;
- May require the NRC to characterize nonnuclear risks (e.g., natural disasters and other energy supplies)

# Population-Related Siting Considerations Discussions



## **Using GEIS In Support of the Construction and Operation of Advanced Nuclear Reactors**

Rich Powell, Executive Director, Clearpath  
Jeffrey Merrifield, Legal Advisor, Member of the Board of Directors, Clearpath  
(June 2019)

# Overview

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## 1 It is time to streamline environmental review procedures for licensing advanced nuclear

**a** Goal: Balance realistic environmental risks with business needs of industry

## 2 Overarching policy considerations

**a** Clean energy solutions include nuclear energy

**b** U.S. leadership in technology and addressing global energy and environmental needs

**c** Role of the private sector in driving technological innovation

## 3 Executive branch directives to streamline NEPA procedures

# Market Conditions Favoring ANR Licensing

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<b>1</b> Factors driving Advanced Nuclear	<ul style="list-style-type: none"><li>• Increasing domestic energy needs</li><li>• High costs and technical difficulties of building large, light-water reactors</li><li>• Increased public/policymaker emphasis on low-carbon emitting tech</li></ul>
<b>2</b> NuScale	SMR could be licensed within next 2 years
<b>3</b> NRC FY19 Budget	Anticipates a non-LWR microreactor application
<b>4</b> Collaboration	NRC collaboration with DoD on new microreactors



# Regulatory/Legislative Development Favoring GEIS Initiative

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**ClearPath's initiative is timely and consistent in light of recent legislative activity, declarations of policy, executive orders, rulemakings:**

- Title 41 of the Fixing America's Surface Transportation Act (12/4/15) -- P.L.114-94
- E.O. 13807 - Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects." (8/15/17)
- Council on Environmental Quality's Advanced Notice of Proposed Rulemaking (6/20/18)
- FY19 National Defense Authorization Act (7/25/18) - P.L.115-232
- Nuclear Energy Innovation and Modernization Act (1/14/19) - P.L.115-86
- Senate letter -- Chairman Barrasso and Chairman Braun

**Common themes: Greater efficiency and accountability in infrastructure projects, including licensing of new reactors**

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# Need for Improvement in Current Environmental Review Procedures

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## Current environmental review procedures are overly burdensome and duplicative

- NEPA review involving EIS often takes years to complete and addresses unrealistic or redundant environmental risks
- Environmental permitting, which was in early stages when NEPA regulations promulgated, makes elements of EIS redundant or unnecessary
- NRC requirement to prepare an EIS for the construction and operation of nuclear reactors reflects the Commission's interpretation of CEQ's NEPA regulations

## NEPA regulations afford flexibility in how environmental reviews are conducted and requires avoidance of duplicative efforts

40 CFR 1502.4 authorizes use of GEIS: “agencies may find it useful to evaluate proposals ... generically, including actions which have relevant similarities, such as common timing, impacts, alternatives, methods of implementation, media, or subject matter.”

## GEIS that NRC has issued to date offer a workable framework for the proposed GEIS for ANR

## Scope of Proposed GEIS

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**Applies to a subset of Generation III+ and IV advanced nuclear reactors, consisting of:**

“Both non-light water reactors and small modular light water reactors (including micro-reactors of 50 MW or less), with passive or inherent safety features that require comparatively fewer controls or operational intervention to avoid accidents in the event of malfunction, and rely on natural forces such as gravity, natural convection, or resistance to high temperatures.”

**Accounts for, among other things, the criteria specified in Section 3 of The Nuclear Energy Innovation and Modernization Act (S. 512)**

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# Proposed Framework for GEIS

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**1** Prepare a flexible, wide-ranging GEIS that can be supplemented with a SEIS to address specific issues unsuitable for generic treatment

**2** The GEIS must address the key portions of an EIS:

- Description of affected environment
- Identification of environmental issues subject to construction and operational impact analysis
- Alternatives analysis

# Proposed Framework for GEIS (cont.)

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## 1

### Description of Affected Environment

**NRC already has provided generic descriptions of the affected environment in GEIS issued to date**

**GEIS for License Renewal (NUREG-1437) is particularly instructive**

- Has been followed in subsequent GEIS (i.e., NUREG-2157, at p. 3-1)
- Covers the fleet of licenses nuclear power plants, as it existed in 2013
- Should be updated to account for physical setting of possible future reactor sites (e.g., Alaska, Puerto Rico, islands)
- Should be updated to elaborate upon design variations of different advanced nuclear reactor models

## Proposed Framework for GEIS (cont.)

### 2

Construction and operational impacts and mitigation measures

**Not all potential operational impacts need to be subject to uniform treatment**

**NUREG-1437 shows that GEIS is appropriate for projects where vast majority of potential environmental impacts will be minor or capable of being mitigated through commonly available means**

- 59 of 78 potential environmental impacts in NUREG-1437 are treated generically
- 19 of 78 are subject to site-specific treatment in a SEIS

**Factors supporting generic treatment in the proposed GEIS for ANRs**

- ANRs are zero-carbon emitters
- Construction-related impacts minimal and of short duration for SMRs, similar to plant decommissioning (NUREG-0586), which NRC has decided to treat generically
- Acknowledgement that environmental permitting covers issues addressed in EIS

## Proposed Framework for GEIS (cont.)

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### 3

#### Alternatives Analysis

**No need for rigorous “purpose of and need for” alternatives analysis, given the reality that project development reflects a reasoned determination by:**

- Governmental authorities; or
- Private parties

**No need for rigorous alternatives analysis when the appropriate comparisons are to conventional baseload deployments involving existing technologies, e.g.,:**

- Coal- or gas-fired plants
- Commercial nuclear reactor designs

# Concluding Thoughts

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## Developing a GEIS for the construction and operation of advanced reactors will ultimately:

- 1 Focus environmental review efforts on the most important aspects of licensing
- 2 Take advantage of useful GEIS “precedents” developed by NRC
- 3 Reduce NRC staff resources dedicated to environmental permitting
- 4 Meet objectives under EO 13807 and various legislation advocating streamlined permitting
- 5 Meet the objectives under NEIMA for accelerating the development of advanced reactors
- 6 Meet all statutory obligations under both CEQ’s and NRC’s current environmental regulations



# Codes and Standards for Advanced Reactors

Mike Tschiltz

June 27, 2019



# Codes and Standards for advanced reactors have the potential to provide significant benefit to developers

- Consensus standards have been useful in the past and are expected to be as useful for advanced reactors
- Provide an easier pathway for justifying adequacy of design (enables more efficient licensing reviews)
- The absence of codes and standards will potentially result in the introduction of additional conservatisms that have the potential to negatively impact plant economics (Potential to optimize safety and cost)
- Increasing demand to expand the use of risk-informed approaches
- Potential to reduce costs and time to market (new methods and materials, e.g., advanced manufacturing)
- Potential to improve marketability of design within US and internationally (build investor interest and confidence)

# Potential Barriers to Success

- There are too many standards in various states of development to all be useful for the "first to market" designs...need to identify most important and useful and drive them to completion; highlights the importance of coordination and prioritization
- Challenge of linking developer needs to standards organization priorities
- Government funding is needed to support key R&D tasks so that data and analytical tools are available to support advanced reactor design and deployment
- Need cooperative efforts involving designers, broader industry orgs, SDOs, and government bodies (DOE, NIST, and NRC) to bring key C&S to completion to support 2030 deployments
- Accelerating effort is essential to reduce the time to develop and obtain NRC endorsement of new consensus standards

# NEI Needs Assessment and Prioritization



- Seek developers views as to what codes and standards are most important to pursue in the near-term
- Identify common needs/priorities for diverse technologies
- Seeking input from National Labs for advanced reactor technology leads
- Need to establish forums for codes and standards organizations to interact with Advanced Reactor developers
- Resources are a challenge.. there is a need for government funding/support
- How can activities be accelerated

# Activities focused on solving the problem

- ORNL/SR-2017/520, Assessment of Applicability of Standards Endorsed by Regulatory Guides to Sodium Fast Reactors
- May 2, 2018 American Nuclear Society (ANS) /NRC Workshop to Develop a Strategic Vision for Advanced Reactor Standards
- ANS Draft Report of the Special Committee on Advance Reactor Policy
- NEI Draft Report - ADVANCED REACTOR CODES AND STANDARDS NEEDS ASSESSMENT AND PRIORITIZATION
- ASME outreach to NEI

# Questions

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# Interim Staff Guidance for Micro-reactor Environmental and Siting Reviews

Mallecia Sutton  
Senior Project Manager  
Division of Advanced Reactors

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# Agenda

- How Different Types, Sizes, and Uses for Micro-reactors Affect Environmental Review
- Environmental Interim Staff Guidance (ISG)
- Site Safety ISG



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# How Different Types, Sizes, and Uses for Micro-reactors Affect Environmental Review

- Micro-reactors may have substantially reduced environmental impacts
- Certain factors and inherent safety features in micro-reactors could reduce level of detail in environmental documents
- NRC regulations require that environmental “impacts should be discussed in proportion to their significance” (10 CFR 51.45(b)(1))
- NRC’s approach includes near-term and long-term activities

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# ISG Topics

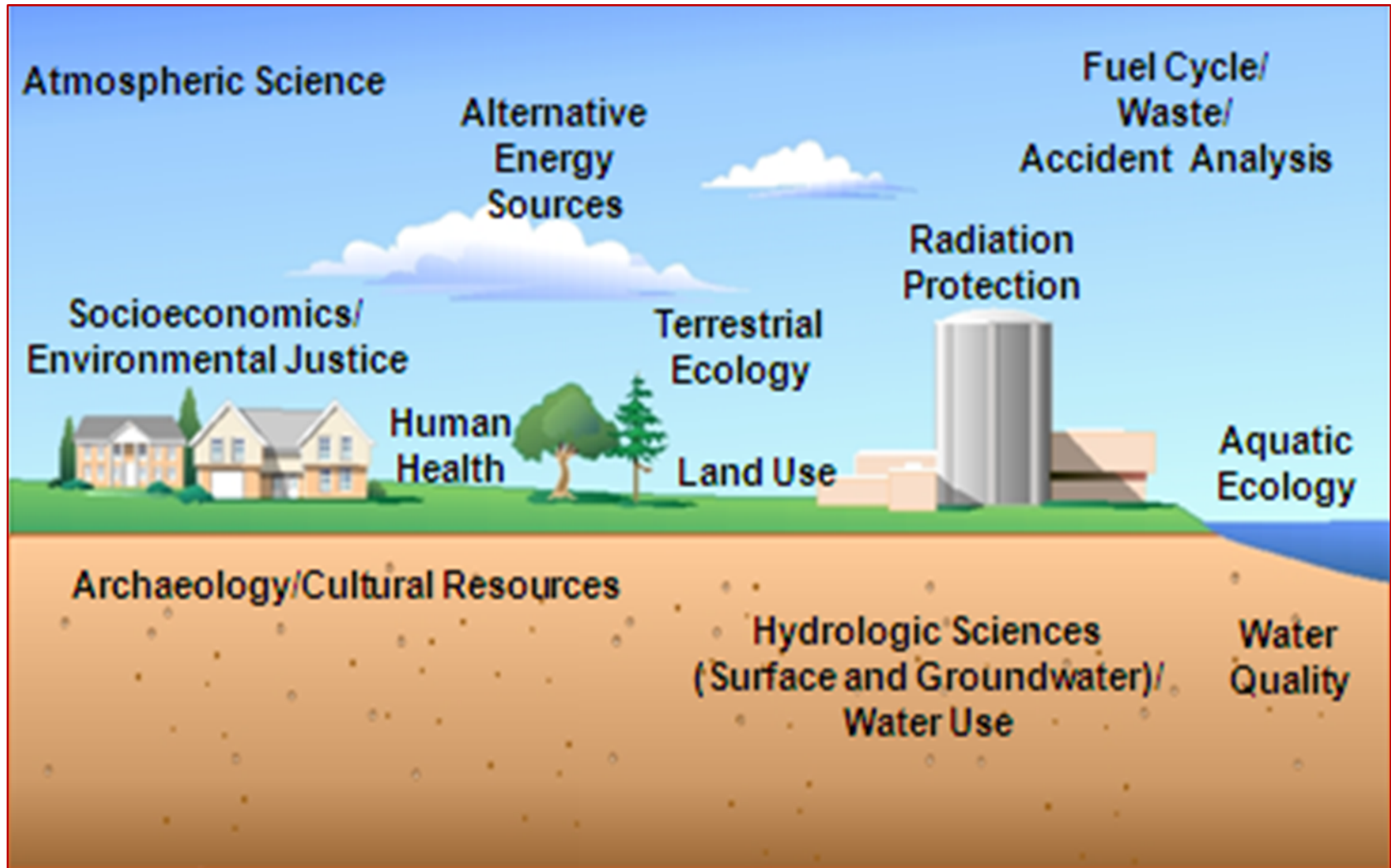
- Non-LWR, micro-reactor considerations
- Scale of review based on footprint and resources used
- Socioeconomic impact
- Purpose and need for project
- Alternatives

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# Purpose and Need

- Purpose and need statement determines the need for the project and alternatives that can meet the need
- If need is electricity, then existing guidance may be adequate
- If need is not electricity (e.g., desalination), then early engagement with NRC is encouraged to understand need, its justification, and alternative means to meet need

# Resource Areas Typically Considered in Environmental Review



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# Pre-application

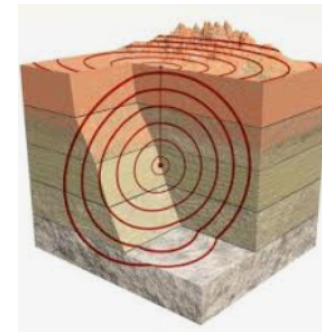
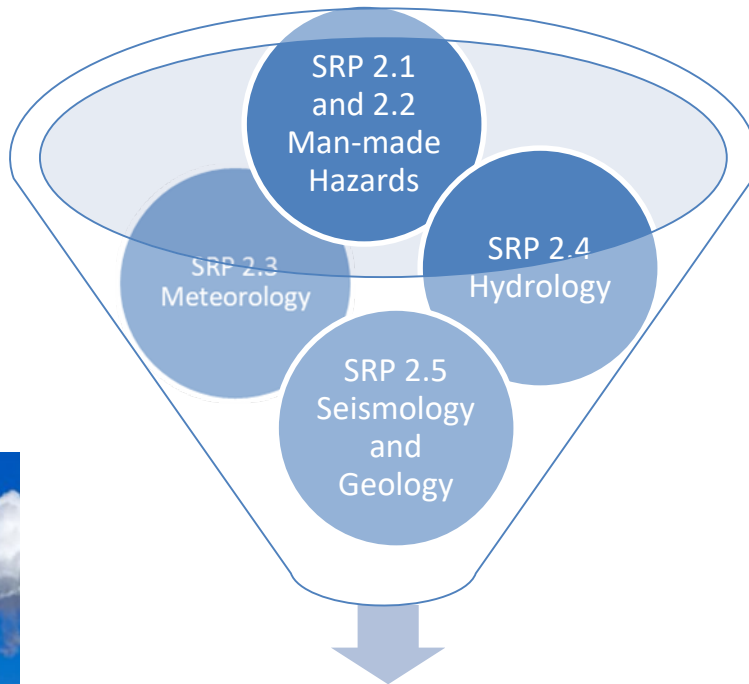
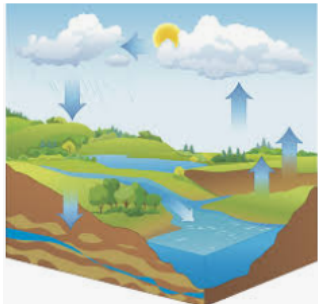
- FAST-41 and EO 13807 outline coordination between all Federal agencies issuing permits for a project
- Each project and site will be different – guidance cannot cover all possibilities
- Pre-application interactions with NRC can facilitate mutual understanding
- Pre-application with NRC and other Federal agencies issuing permits is critical to a successful review

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# Site Safety ISG

- Path for a focused, risk-informed, safety review of external hazards
- Identification and focus on consequential external hazards
- Technical sections will follow a decision tree format for staff to determine which criteria are applicable

# Review Areas



Interim Staff Guidance  
Streamlined Technical Sections

Man-made  
Hazards

Meteorology Hydrology

Geology and  
Seismology

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# Pre-application

- Pre-application process
- Communicate with NRC early and often
- Pre-application interactions can be extremely useful in streamlining the NRC staff's review





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UNITED STATES NUCLEAR REGULATORY COMMISSION

*Protecting People and the Environment*

# **NRC Perspectives on Micro Reactor Licensing**

**Boyce Travis**

**June 27, 2019**

- Staff has interacted with stakeholders over the last several years regarding policy issues for advanced reactor designs
- Recent developments and discussions have shown there are areas where micro reactors differ from other advanced reactor designs and even further from LWRs
- Based on their relatively small size and (to be demonstrated) lower consequences, implementation of some existing regulations may not be fully applicable to micro reactors

- Because of projected interest in micro reactors, early engagement with the Commission on topics where design decisions based on applicable regulations could be made earlier and reduce uncertainty is important
- Staff recently met with management for alignment on development of a micro reactor white paper and engagement with stakeholders
- Plan to issue a SECY paper later this year regarding policy and licensing considerations for micro reactors with examples of specific issues
- Goal is to determine to what degree the issues can be addressed under current regulations and better align micro reactor requirements with their potential consequences



# Regulatory Issues for Consideration

- Security requirements
- Aircraft Impact
- Emergency Preparedness
- Staffing
- Remote Operation
- NRC Oversight
- Fee structure, decommissioning requirements
- Manufacturing licenses and transportation requirements

- Solicitation of stakeholder feedback is important for developing a SECY and helping the staff understand:
  - Is this the correct list? Are there other potential issues yet to be considered?
  - What is the relative importance of the issues? What issues, if any, should be addressed in more detail?
  - What is the projected timeline stakeholders believe the issues need to be addressed by? Are there specific issues that need to be resolved early in the design/application process?
- Other feedback on micro reactor policy issues?

# Micro-Reactors

## Regulatory Topics

Marc Nichol, Director New  
Reactor Deployment

June 27, 2019



# Unique Micro-Reactor Considerations\*

- Typically 1 MWe to 10 Mwe
- Very small size
  - Site <0.1 acres, building ~size of a house, reactor fits in shipping container
- Very small potential consequences
  - Source terms as low as 1% of today's reactors
  - Fail-safe: shuts itself off, cannot meltdown
  - Proliferation resistant fuel
- Operational simplicity
  - Few to zero moving parts
  - Automatic operations
  - Minimal maintenance

\*General description, all features may not be applicable to all designs

# Micro-Reactor Regulatory Issues

Priority Issues	Addressed in Broader Efforts	Non-Urgent
<ol style="list-style-type: none"><li>1. Review Scope, Duration, Level of Effort</li><li>2. Aircraft Impact</li><li>3. Operations (auto/remote)</li><li>4. Resident Inspector</li><li>5. Physical Security</li><li>6. Emergency Preparedness</li></ol>	<ul style="list-style-type: none"><li>• Siting</li><li>• Environmental Reviews</li></ul>	<ul style="list-style-type: none"><li>• Transportation</li><li>• Annual Licensee Fees</li><li>• Fuel</li><li>• Generic License</li><li>• PRA</li><li>• QA</li></ul>

## No issues identified

- Liability Insurance
- Decommissioning Funding





**Endorsement and Gap Analysis of  
ASME/ANS RA-S-1.4  
“PRA Standard for Advanced Non-LWR  
Nuclear Power Plants”**

**Advanced Reactor Stakeholder Meeting**

Mary Drouin, RES/DRA

Hanh Phan, NRO/DAR

June 27, 2019

# Non-LWR PRA Standard

- ASME/ANS RA-S-1.4 provides an acceptable means to establish the scope and technical adequacy of the PRA
- Developed by the ASME/ANS Joint Committee on Nuclear Risk Management (JCNRM)
- Development began in 2006
- In trial use since 2013
- 14 pilot cases
- All-inclusive of Level 1, Level 2, Level 3, at-power, and low power and shutdown
- 18 elements that cover internal events, internal hazards, and external hazards
- >200 High Level Requirements (HLRs) and >1,000 Supporting Requirements (SRs)



# **Action Plan for Reviewing and Endorsing Non-LWR PRA Standard**

Mary Drouin

# Outline of Plan

- Objectives and Scope
- Tasks
  - ♦ Task 1: Supporting development of the standard
  - ♦ **Task 2: Preparation for review of the standard**
  - ♦ **Task 3: Reviewing the standard**
  - ♦ Task 4: Maintaining PRA standard
  - ♦ **Task 5: Development of schedule**
  - ♦ Task 6: Identification of resources
  - ♦ Task 7: Development of communication plan

# Task 2: Preparation for Review of the Standard – Involves 6 Subtasks (1/2)

- Subtask 2-1: Determine the scope of regulatory risk-informed activities (draft completed)
  - ♦ Identify and describe each type of application for the various licensing stages (e.g., design certification, operational) with the needed PRA scope
  - ♦ Identify, for each application, the capability category, that is, whether the supporting requirements need to be Capability Category I or II
- Subtask 2-2: Comparison of the non-LWR PRA standard to the LWR PRA standard
  - ♦ Understand the difference between the non-LWR and LWR standard
- Subtask 2-3: Identify the needed technical expertise to review the standard (draft completed)

# Task 2: Preparation for Review of the Standard – Involves 6 Subtasks (2/2)

- Subtask 2-4: Develop staff position for an acceptable non-LWR PRA (task initiated)
  - ♦ Define the objectives for each technical element, considering the different applications
  - ♦ Define the technical attributes and characteristics needed to accomplish the objective
  - ♦ Develop the staff position on an acceptable peer review process, addressing an acceptable peer review process, team qualifications, and documentation
- Subtask 2-5: Identification and resolution of technical and policy issues
  - ♦ Review each technical element associated with each risk level and hazard, for each application type, and identify possible technical or policy issues
  - ♦ Describe the significance of the issues
  - ♦ Identify whether there is ongoing research to address the issues and what research are needed
- Subtask 2-6: Guidance for staff review of non-LWR PRA standard for endorsement (draft completed)
  - ♦ Guidance on how to approach the review
  - ♦ Criteria for determining acceptance (no objection)

# Review Criteria (1/2)

- Provide the ASME guidance for a standard including the rules balloted by JCNRM
- Staff position used to answer the review criteria
- Provide review criteria for the PRA generalist versus a technical experts (e.g., human reliability analyst, seismic analyst)
- PRA generalist -- Looking more at the entire standard for consistency and cohesiveness, for example:
  - ◆ Has terminology been consistently used?
  - ◆ Issues treated consistently?
  - ◆ Objective and scope of standard clear and consistent with the technical elements?

# Review Criteria (2/2)

- PRA technical experts -- Looking more at the technical soundness of the requirements, for example:
  - ♦ Is a given HLR achieved if all the associated SRs are met?
  - ♦ Can the SRs achieve what is required by the HLR?
  - ♦ Are the SRs complete? That is, do the SRs describe the minimum set of requirements needed to achieve the HLR been identified?
  - ♦ Does the scope of the SRs match the scope of its HLR?
  - ♦ Are the SRs technically sound?
  - ♦ Are the SRs asking the analyst to do more than required by the HLR?
  - ♦ Are the SRs asking the analyst to do less than required by the HLR?



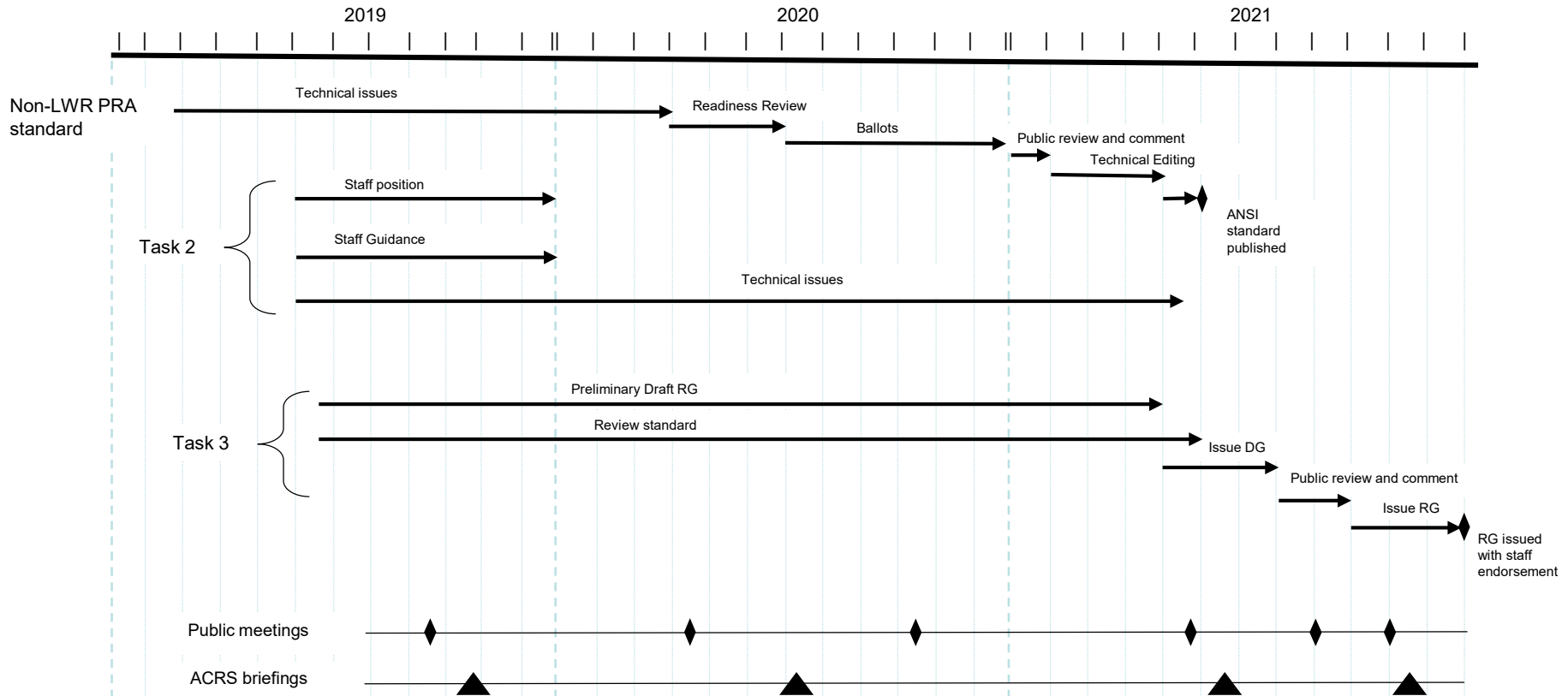
# Task 3: Reviewing the Standard

- Subtask 3-1: Develop draft regulatory guide
  - ♦ A technically acceptable PRA
  - ♦ Use of consensus PRA standards and related industry PRA programs
  - ♦ Demonstrating the technical acceptability of the PRA to support a regulatory application
  - ♦ Documentation needed to support a regulatory submittal
- Subtask 3-2: Review PRA standard
  - ♦ Review each requirement against the characteristics and attributes for an acceptable PRA
  - ♦ Review the standard for cohesiveness and technical soundness
  - ♦ Identify any additional issues
- Subtask 3-3: Finalize RG
  - ♦ Issue the draft guide for public review and comment
  - ♦ Evaluate public comments and revise the DG where appropriate
  - ♦ Issue final RG for use

# Task 5: Development of Schedule

- Objective:
  - ◆ Develop a schedule for the various tasks  
(This schedule will of necessity be conditional on the completion of the necessary standards documents)
- Effort:
  - ◆ Develop a timeline of the various tasks and related efforts
  - ◆ Identify key milestones associated with the various tasks and their anticipated completion dates

# Tentative Schedule



# Status and Path Forward

- Draft staff action plan (completed)
- Draft staff review guidance (completed)
- Initiated development of staff position
- Staff options:
  - ♦ Review and endorse trial use standard which is publicly available?

OR

- ♦ Review and endorse ANSI standard which will not be publicly available until mid-2021?



**Gap Analysis of  
Non-LWR PRA Standard  
ASME/ANS RA-S-1.4 to  
Ensure Fit for Licensing  
Modernization Project (LMP) Purpose**

Hanh Phan

# Objective

- Assess the technical applicability and suitability of the non-LWR PRA standard to ensure fit-for-purpose HLRs and SRs
- Address how the DC and COL applicants can use the standard for determining the technical adequacy and acceptability of PRA
- Ensure that the PRA relied on by the applicant is sufficient to provide confidence in the results and risk insights

# Tasks

Some SRs in the standard cannot be achieved as written or may need clarification to understand how they can be achieved.

- Evaluate the feasibility of meeting the SRs
- Determine additional SRs to be necessary to address special conditions
- Provide staff's positions on using the standard and gaps in the SRs

# Product

An interim guidance document (in 2020), which provides an acceptable approach for NRC staff and applicants when using non-LWR PRA standard to demonstrate that the PRA has a sufficient level technical adequacy for achieving LMP requirements. Designate staff's position on each SR as:

- **No Objection** - Staff has no technical objection to the HLR or SR as written when used in the context of the LMP
- **Clarification** - Certain aspects of the HLR or SR need to be clarified; the staff will provide a discussion that addresses any lack of clarify or ambiguity
- **Qualification** - Staff has a technical concern with the HLR or SR in the context of LMP; resolution may include:
  - ◆ Enhancing the existing SR
  - ◆ Replacing the existing SR
  - ◆ Creating a new SR
  - ◆ Providing guidance for addressing the SR



# Preparing for Advanced Reactor Reviews: Pre-Application Interactions

Steven Lynch

Acting Chief, Advanced Reactor Licensing Branch  
Division of Advanced Reactors

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# New Organization, Familiar Approach

- Division of Advanced Reactors consists of technical, policy, and licensing branches
- Continued commitment to facilitating successful pre-application interactions, providing regulatory transparency, encouraging open communication, and ensuring coordination between the NRC and stakeholders

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# Advanced Reactor Policy Statement

*“To provide for more timely and effective regulation of advanced reactors, the Commission encourages the earliest possible interaction of applicants...and the NRC to provide for early identification of regulatory requirements for advanced reactors and to provide...a timely, independent assessment of the safety and security characteristics of advanced reactor designs. Such licensing interaction and guidance early in the design process will contribute towards minimizing complexity and adding stability and predictability in the licensing and regulation of advanced reactors.”*

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# Elements of Success

- A shared understanding of what to expect and when to expect it supports an effective application review
- Goals for pre-application engagement:
  - Frequent and early communication
  - Consistent expectations and experiences
  - Identification and resolution of technical, policy, and licensing issues prior to application submission

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# Initiating Interactions

- Coordination begins years before the submission of a license application
- When ready to discuss design and application information:
  - Respond to Regulatory Issue Summary RIS-17-08 on scheduling and budgeting advanced reactor reviews
  - Participate in Advanced Reactor Stakeholder Meetings
  - Establish points of contact for ongoing communication
  - Schedule drop-in meeting with NRC management
- Following initial pre-application engagement, a project number will be established to track pre-application review activities

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# Types of Interactions

- Regulatory Review Roadmap for Non-Light Water Reactors provides options for formal application reviews and pre-application engagement
- Formal: Sharing of technical and licensing information supporting an action requested of the NRC staff (e.g., permits, licenses, certifications), which may be supported by public meetings and docketed correspondence
- Informal: Sharing of general and administrative information for planning and coordination purposes, supported by drop-in meetings and routine phone calls and e-mail correspondence

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# Tools for Facilitating Communication

- NRC staff committed to adapting the type, scope, formality, and frequency of pre-application interactions
  - Public and non-public meetings
  - Drop-in meetings
  - Periodic calls with project manager
  - Licensing Project Plans and Regulatory Engagement Plans

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# Transmitting Information

- Prospective applicants may submit technical reports, topical reports, white papers, and other documents to the NRC
- Written correspondence should be submitted in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.4 to either the Document Control Desk or via Electronic Information Exchange
- Informal and reference documents, including courtesy copies may be shared using:
  - Box
  - Electronic reading room
  - E-mail



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# Protecting Information

- NRC must protect classified and sensitive unclassified non-safeguards information (SUNSI)
  - Classified information
  - SUNSI (e.g., proprietary, security-related, export controlled information (ECI))
  - Safeguards Information

*Note: The NRC does not designate ECI.*

*ECI designation should be coordinated with appropriate federal agency (e.g., Department of Energy, Department of Commerce).*

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# Requests for Withholding

- Per 10 CFR 2.390, prospective applicants may request that proprietary information be withheld from public disclosure
- Requests for withholding must be accompanied by an affidavit
  - Affidavit should be either notarized or signed under oath or affirmation
  - Identify what information is considered proprietary
  - Explain why the release of information would cause harm
- Sensitive information, including proprietary information and ECI should include appropriate portion and page markings
- Non-proprietary (public) versions of documents should be provided with proprietary submittals
- NRC staff will evaluate requests and determine whether information should be withheld from public disclosure

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# Shared Expectations

- NRC staff commitments:
    - Timely responses to review requests
    - Clear communication of positions, findings, requests for information
    - Predictable and consistent expectations, processes, and schedules
    - Transparent level of effort and cost estimates
  - Support from potential applicants
    - Regular communication, including administrative and technical updates and discussions
    - Engagement on technical, policy, and licensing issues
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# Preparing for Application Submission

- Submitting an application, while beginning a formal review, is also the culmination of years of preparation

## Goal of Pre-Application Activities:

*Support effective application preparation and review*

- Pre-application Readiness Assessment provides mechanism for staff and prospective applicant to discuss contents of application ahead of submittal
  - Identify information gaps
  - Identify major technical or policy issues
  - Become familiar with the application

# Sample Application Readiness Timeline

Milestone	Schedule
Applicant submits any remaining topical and technical reports for NRC review	T - 18 months
Necessary Applicant programs in place (e.g., quality assurance program plan, safeguards information protection plan)	T - 12 months
Applicant selects site (if applicable) and begins environmental pre-application interactions	T - 12 months
NRC completes reviews of pre-application submittals	T - 6 months
NRC conducts Application Readiness Assessment	T - 6 months
Applicant develops Packing Slip Wizard structure for electronic submittal	T - 6 months
NRC develops baseline schedule and resource estimates	T - 4 months
NRC conducts any necessary audits (e.g., probabilistic risk assessment audit)	T - 3 months
Applicant conducts trial run of electronic application submission	T - 1 month
Application submitted	T = Submission Date

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# Next Steps

- Engage with NRC staff on pre-application topics
  - Project managers serve as primary point of contact for arranging meetings, answering questions, and coordinating submissions
- Future licensing discussion topics:
  - Insights on sensitive information redactions
  - Keys to successful meetings with the NRC
  - Facilitating communication during reviews
  - Establishing effective review schedules
  - Suggestions?

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# Reference Documents

- Regulatory Review Roadmap for Non-Light Water Reactors. (ADAMS Accession No. ML17312B567)
  - Regulatory Issue Summary 2017-08, “Process for Scheduling and Allocating Resources for Fiscal Years 2020 Through 2022 for the Review of New Licensing Applications for Light-Water Reactors and Non-Light-Water Reactors.” (ADAMS Accession No. ML17262B022)
  - Nuclear Energy Institute 18-06, “Guidelines for Development of a Regulatory Engagement Plan.”
  - Management Directive 3.5, “Attendance at NRC Staff-Sponsored Meetings.” (ADAMS Accession No. ML18073A094)
  - NRC Office Instruction REG-104, “Pre-application Readiness Assessment.” (ADAMS Accession No. ML14079A197)
  - NRC Office Instruction LIC-204, “Handling Requests to Withhold Proprietary Information from Public Disclosure.” (ADAMS Accession No. ML093240489)
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# NRC Review and Endorsement of ASME BPVC Section III, Division 5

## Advanced Reactor Stakeholder Meeting

June 27, 2019



# Background – NRC Use of Codes and Standards

- Federal law requires Government staff to use consensus standards where possible
  - National Technology Transfer and Advancement Act of 1995 (Public Law 104-113)
  - Office of Management and Budget (OMB) Circular A-119
- NRC Management Directive 6.5, “NRC Participation in the Development and Use of Consensus Standards” (MD 6.5)
  - Provides direction for implementing the Act of 1995 and OMB Circular A-119
- NRC Implementation Action Plans (IAP)
  - IAP 4: *Facilitate industry code & standards development needed to support the non-LWR lifecycle, including fuels & materials*

# Background – ASME BPVC

- ASME BPVC establishes rules of safety relating to the pressure integrity of boilers, pressure vessels, transport tanks, and nuclear components.
- ASME BPVC, Section III establishes rules for material, design, fabrication, examination, testing, overpressure, and quality assurance of nuclear components.
- ASME BPVC, Section III, Division 1 establishes rules for components where material strength and deformation is time-independent.
  - ASME BPVC Section III, Division 1 is incorporated by reference in 10 CFR 50.55a
  - Maximum temperature is 425°C (800°F)
  - Does not address graphite and ceramic-composite components
- ASME BPVC, Section III, Division 5 extends the rules for nuclear components to operate within the creep-regime (time-dependent).

# Background – ASME BPVC Section III, Division 5

- In RG 1.87, “Guidance for the Construction of Class 1 Components in Elevated Temperature Reactors,” the NRC endorsed ASME BPVC Code Cases 1592-0, 1593-0, 1594-0, 1595-0, and 1596-0 with conditions.
  - The NRC is planning on withdrawing RG 1.87. The technical basis of these Code Cases is no longer conservative as evident by the content in ASME BPVC Section III, Division 5.
- The 159X Code Cases were revised and improved over 50 years.
  - The 159X Code Cases
  - Code Case N-47
  - ASME BPVC Section III-NH
  - ASME BPVC Section III, Division 5
- The 2017 Edition of ASME BPVC Section III, Division 5 is sufficient for NRC to review for endorsement.

# Review Expectations

- NRC will create a draft RG by August 2020. Staff will solicit public comments on the draft RG and will subsequently issue a final RG.
- NRC and contractor review will emphasize the “Reasonable Assurance of Adequate Protection” standard. Over conservatism in ASME BPVC Section III, Division 5 may be noted but will not prevent the NRC from endorsement.
- NRC review will integrate current risk-informed regulation policies. The HBB (Class A) rules will be reviewed with the assumption that HBB components have safety-significant functions.
  - Categorization of SSCs is not within the scope of this activity
- NRC reviewers consist of materials, mechanical, and inspection staff from NRR, NRO, and RES
- Contractor review has begun and is on schedule.
  - Final reports are expected by December 2019.

# Review Team (1/2)

- **Task C, Elevated Temperature Metallic Components**
  - PNNL
    - Design, Fabrication, Examination, Testing (HBB; HCB; HGB-3000, -4000, -5000, -6000),
    - Rules for Strain, Deformation, and Fatigue Limits (Mandatory Appendix HGB-I)
    - Rules for Construction of Core Support Structures Without Explicit Consideration of Creep and Stress-Rupture (Mandatory Appendix HGB-II)
    - Rules for Buckling and Instability (Mandatory Appendix HGB-III)
    - Rules for Time-Temperature Limits (Mandatory Appendix HGB-IV)
  - NUMARK/EMCC
    - Rules for use of SA-533 Type B (Mandatory Appendix HBB-II)
    - Rules for Strain, Deformation, and Fatigue Limits (Nonmandatory Appendix HBB-T)
    - Rules for Stress Range Reduction Factors (Mandatory Appendix HCB-I)
    - Rules for Allowable Stress Values for Class B Components (Mandatory Appendix HCB-II)
    - Rules for Time-Temperature Limits (Mandatory Appendix HCB-III)

# Review Team (2/2)

- **Task C, Elevated Temperature Metallic Components (Continued)**
  - ORNL
    - Materials (HBB; HCB; & HGB-2000)
    - Tables and Figures (Mandatory Appendix HBB-I)
    - Guidelines for Restricted Material Specifications (Non-Mandatory Appendix HBB-U)
- **Task B, General Requirements, Low Temperature Metallic Components, and Supports**
  - NRC Staff (All aspects)
- **Task D, Graphite**
  - NRC Staff (General Requirements)
  - NUMARK/EMCC (Technical Requirements)
- **Task E, Code Cases**
  - NUMARK/EMCC (All aspects)

# Potential Policy Issues

- What are the legal requirements for ASME BPVC Section III, Division 5?
  - Section III, Division 5 references portions of Section III, Division 1.
  - Section III, Division 1 is a regulatory requirement (10 CFR 50.55a).
- How should Section III, Division 1 conditions be handled?
  - Staff has considered using similar wording to 10 CFR 50.55a(z) for alternatives in the draft RG.
- Staff will provide guidance in the draft RG.
- Any other topics?
- Questions?


# Backup Slides



# ALLOY 617 CODE CASE BALLOTING ACTIONS

RC #	Item	Section II and III Committees (See Color Key Below For Balloting Actions)								
		WG-ASC	SG-ETD	SG-HTR	SG-MFE	II-SG-NFA	II-SG-SW	BPV-II		
16-994	Permissible base and weld materials, allowable stress values	WG-ASC	SG-ETD	SG-HTR	SG-MFE	II-SG-NFA	II-SG-SW	BPV-II		
16-995	Physical properties and extension of modulus values to higher temperatures	WG-ASC	SG-ETD	SG-HTR	SG-MFE	II-SG-NFA	II-SG-PP	BPV-II		
16-996	Temperature-time limits for NB buckling charts	WG-AM	SG-ETD	SG-HTR	SG-MFE	II-SG-EP	BPV-II	II-SG-NFA	SC-D	
16-997	Huddleston parameters, ISSCs	WG-ASC	SG-ETD	SG-HTR	II-SG-NFA	BPV-II	SC-D			
16-998	Negligible creep, Creep-Fatigue: D-diagram and EPP	WG-CFNC	SG-ETD	SG-HTR	SC-D					
16-999	EPP strain limits	WG-AM	SG-ETD	SG-HTR	SC-D					
16-1000	Fatigue design curves	WG-CFNC	WG-FS	SG-ETD	SG-HTR	SG-DM	SC-D			
16-1001	Alloy 617 Overall Code Case	WG-ASC	WG-AM	WG-CFNC	WG-FS	SG-ETD	SG-HTR	SG-MFE	SC-D	BPV-II
		BPV-III								

Color Key	Balloting Action
	For Review and Approval
	For Review and Comment



# ASME QME-1 and Advanced Reactor Material Qualification for Functional Capability

## Advanced Reactor Stakeholder Meeting

June 27, 2019

# ASME QME-1

- ASME Standard QME-1-2017, “Qualification of Active Mechanical Equipment Used in Nuclear Facilities,” specifies provisions and guidelines for the qualification of active mechanical equipment whose function is required to ensure the safe operation or safe shutdown of a nuclear facility, including seismic qualification.
- Active mechanical equipment in advanced reactors will be exposed to operating temperatures within the creep temperature regime and may not be capable of performing their credited safety functions under high temperature conditions because of interference between moving parts, growth or reduction in internal flow clearances, increased wear of internal parts, and other factors.

# ASME QME-1

- The ASME Qualification of Mechanical Equipment (QME) Standards Committee has expressed interest in updating ASME Standard QME-1-2017 to improve its provisions for the qualification of active mechanical equipment used in advanced reactors.
- QME Standards Committee is asking NRC staff experts for suggestions regarding material qualification for high temperature reactors, such as the consideration of creep, for use in developing an update to ASME Standard QME-1.
- The QME Standards Committee might consider this guidance for incorporation as a General Requirements Nonmandatory Appendix, and later as input into ASME Standard QME-2, which is being planned for development.

# ASME QME-1

- Path forward:
  - The NRC will continue to support the ASME QME Standards Committee through their normal processes.
  - The NRC sees the need for development of this standard if advanced reactors will utilize active components for safety-significant or risk-significant functions.
  - A coalition of the willing will be needed to guide the development of the standard.
  - The ASME QME Standards Committee has asked the NRC or another party (DOE or NEI) to provide suggestions regarding materials qualification for high temperature reactors.
  - The NRC staff might be able to provide recommendations for development of input for the QME-1 standard regarding materials qualification for high temperature reactors.