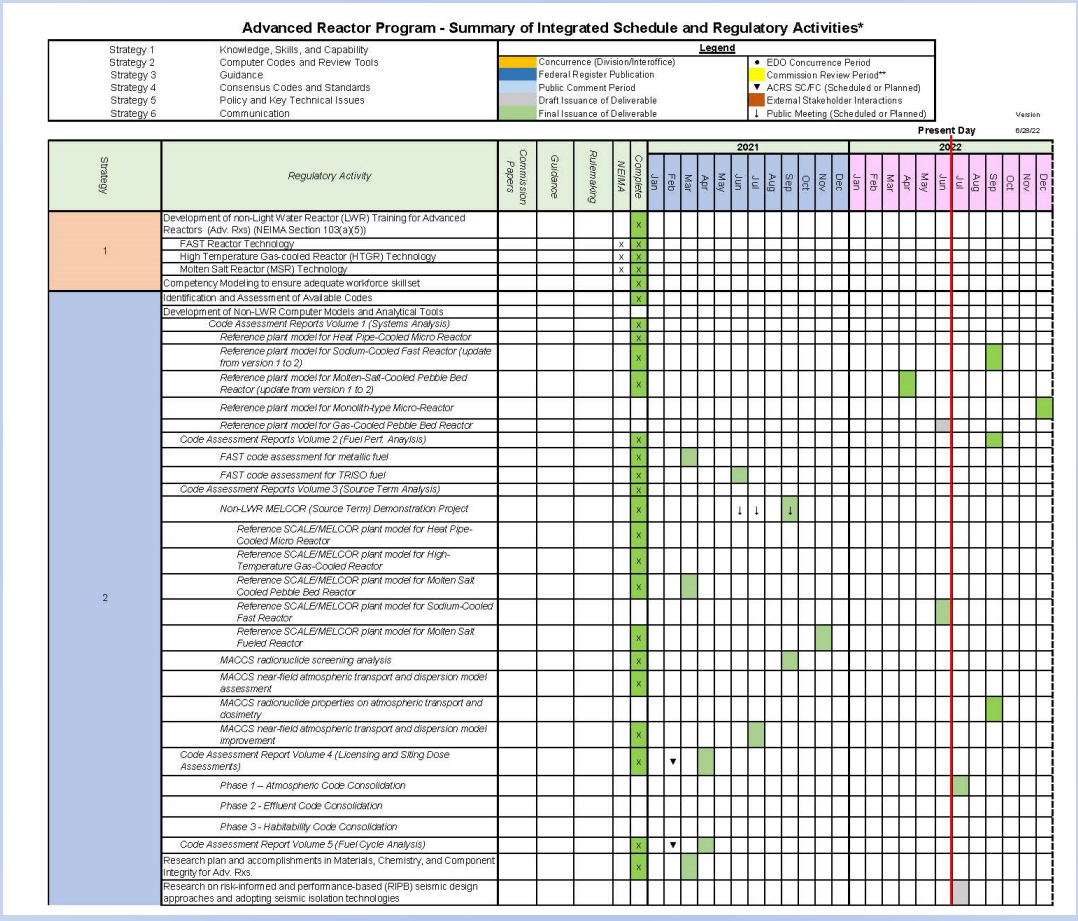
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Advanced Reactor Stakeholder Public Meeting

June 30, 2022

Microsoft Teams Meeting
Bridgeline: 301-576-2978
Conference ID: 625 515 774#

Time	Agenda	Speaker
10:00 – 10:15 am	Opening Remarks/ Adv. Rx Integrated Schedule (Shelley Pitter - Logistics, Steve Lynch)	NRC
10:15 – 10:30 am	Expanding and Internationalizing the EPRI Advanced Reactor Owner-Operator Requirements Guide (ORG) (Marc Albert)	EPRI
10:30 – 12:00 pm	Part 53 - Stakeholder Perspectives on Framework B, Framework A, and NRC Stakeholder Engagement Process (Cyril Draffin, USNIC/Marc Nichol, NEI)	Stakeholders
12:00 – 1:00 pm	**Lunch Break**	All
1:00 – 1:45 pm	Part 53 - Stakeholder Perspectives on Framework B, Framework A, and NRC Stakeholder Engagement Process (Rani Franovich, BTI/ Steve Nesbit, ANS)	Stakeholders
1:45 – 2:30 pm	Regulatory Priorities for New and Advanced Reactors (Kati Augsten)	NEI
2:30 – 2:40 pm	**Break**	All
2:40 – 4:35 pm	Part 53 Subpart F Staffing Requirements (Jesse Seymour)	NRC
4:35 – 4:55 pm	U.S.-NRC-CNSC Memorandum of Cooperation: Joint Report, TRISO Fuel Qualification Assessment (Jeffrey Schmidt)	NRC
4:55 – 5:00 pm	Future Meeting Planning and Concluding Remarks	NRC



https://www.nrc.gov/reactors/new-reactors/advanced/integrated-review-schedule.html

Expanding and Internationalizing the EPRI Advanced Reactor Owner-Operator Requirements Guide (ORG) (Marc Albert)

Internationalization of the EPRI Advanced Reactor Owner-Operator Requirements Guide

An Opportunity for Harmonization and Collaboration

Andrew Sowder, Ph.D., CHP
Advanced Nuclear Technology Program

Jeremy Shook, PmP
Advanced Nuclear Technology Program

Marc Albert, PE
Advanced Nuclear Technology Program

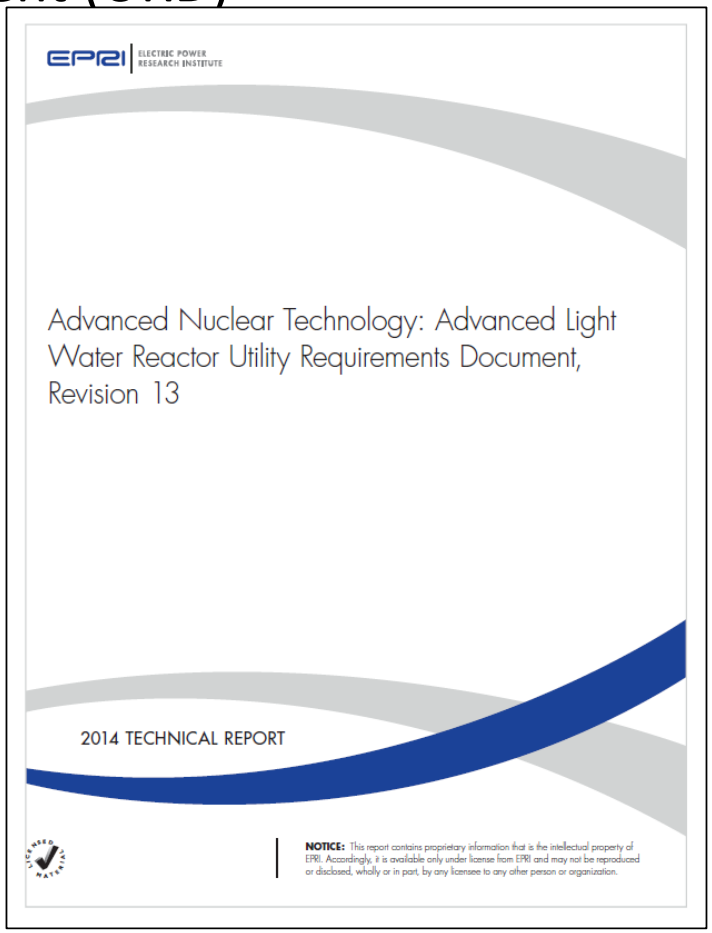
June 30, 2022

Current Status of EPRI Owner-Operator Requirements Guidance

EPRI Utility Requirements Document (URD)

- Key element of EPRI-led Advanced Light Water Reactor (ALWR) program to revive prospects for new nuclear deployment for
  - Capturing 1000's of reactor-years of experience
  - Realizing significant safety improvements
  - Stabilizing regulatory basis
  - Regulatory optimization
  - Promote standardization
  - Reduce capital and O&M costs
  - Restore investor confidence

- Last update (Rev. 13) in 2014*
- Incorporates requirements for small modular LWRs (smLWRs) and Fukushima lessons learned



Advanced Nuclear Technology: Advanced Light Water Reactor Utility Requirements Document, Revision 13. EPRI, Palo Alto, CA: December 2014. 3002003129.
https://www.epri.com/research/products/000000003002003129

EPRI Advanced Reactor Owner-Operator Requirements Guide

What does the customer want? What will the future energy market need?

Owner-Operator Requirements Guide (ORG) for Advanced Reactors

PURPOSE: Provide a common framework to align AR design attributes with customer needs:

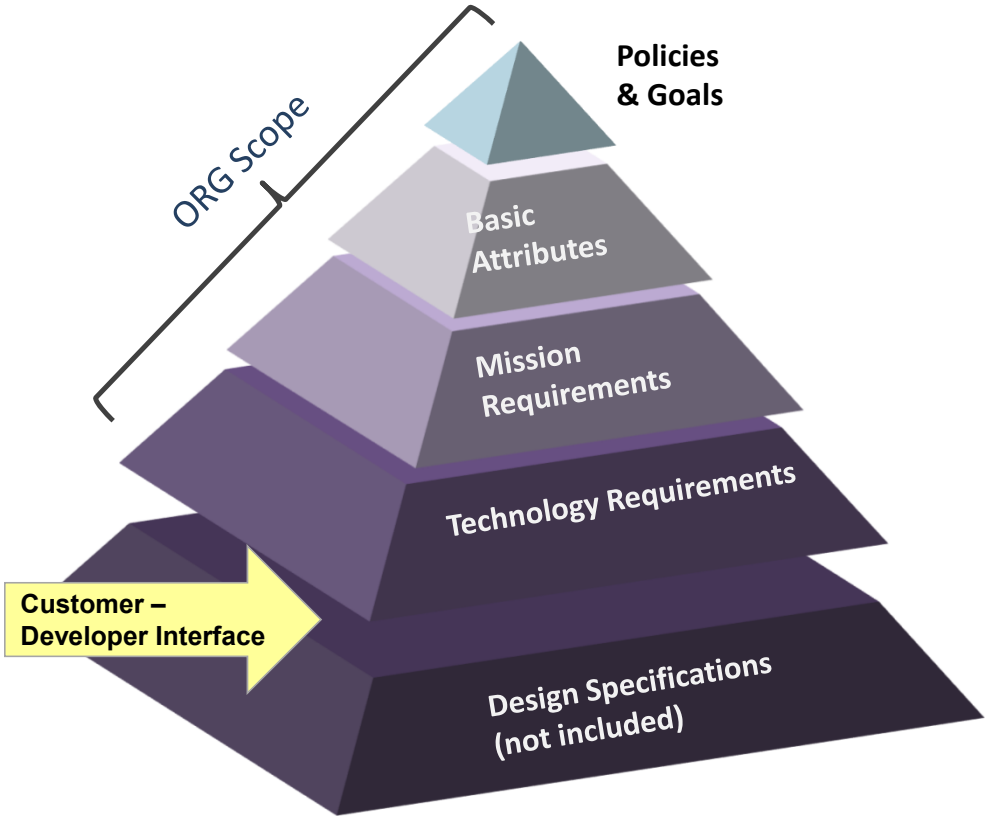
- Flexible and living document
- Technology and mission inclusive

VALUE: Inform and support commercial development and adoption of ARs for potentially greater impact than the Advanced Light Water Reactor program and URD

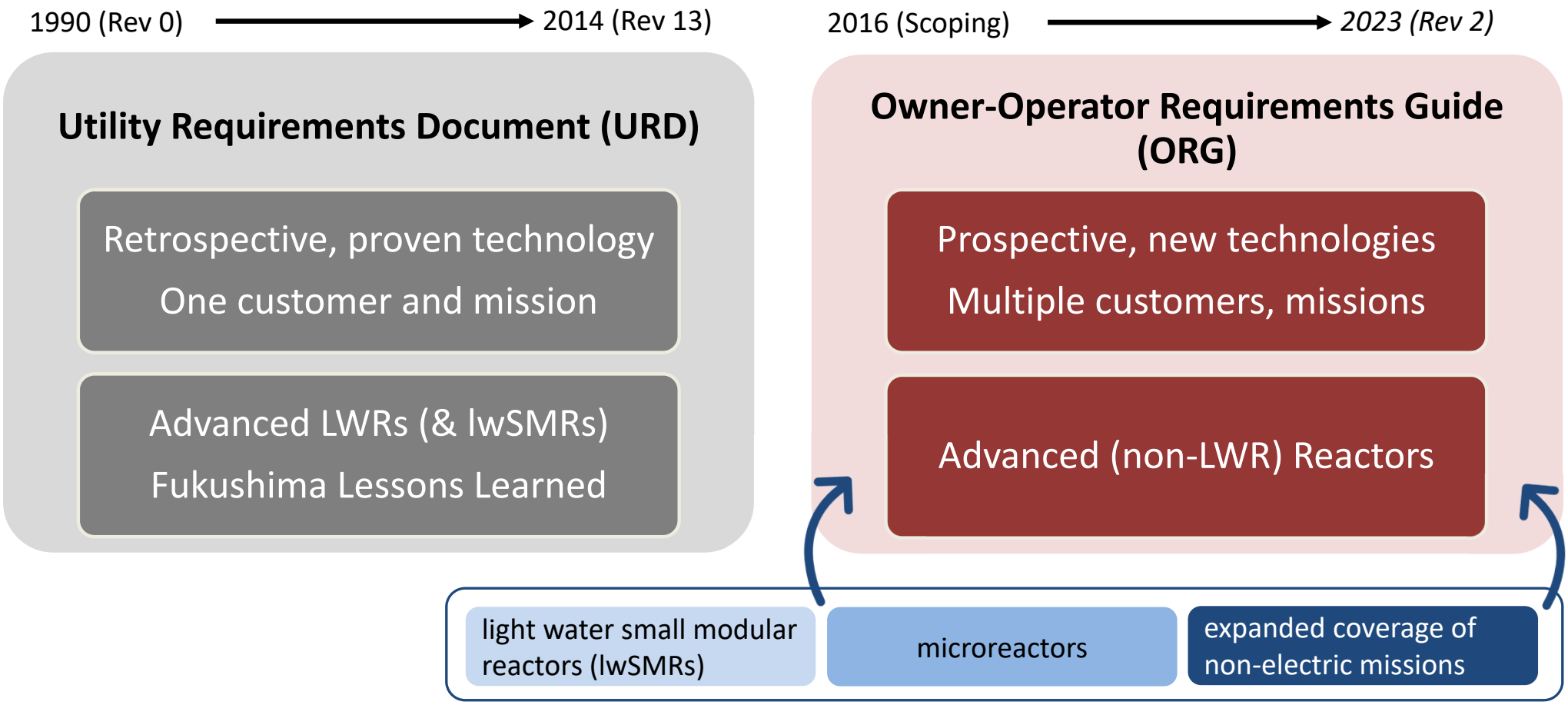
GLOBAL RELEVANCE: Nonprescriptive approach applicable by international stakeholders at all stages of commercial maturity

STATUS: Revision 1 published June 2019 (Report 3002015751)

Scoping study for Revision 2 completed May 2022



EPRI URD vs. ORG (and planned ORG revision)

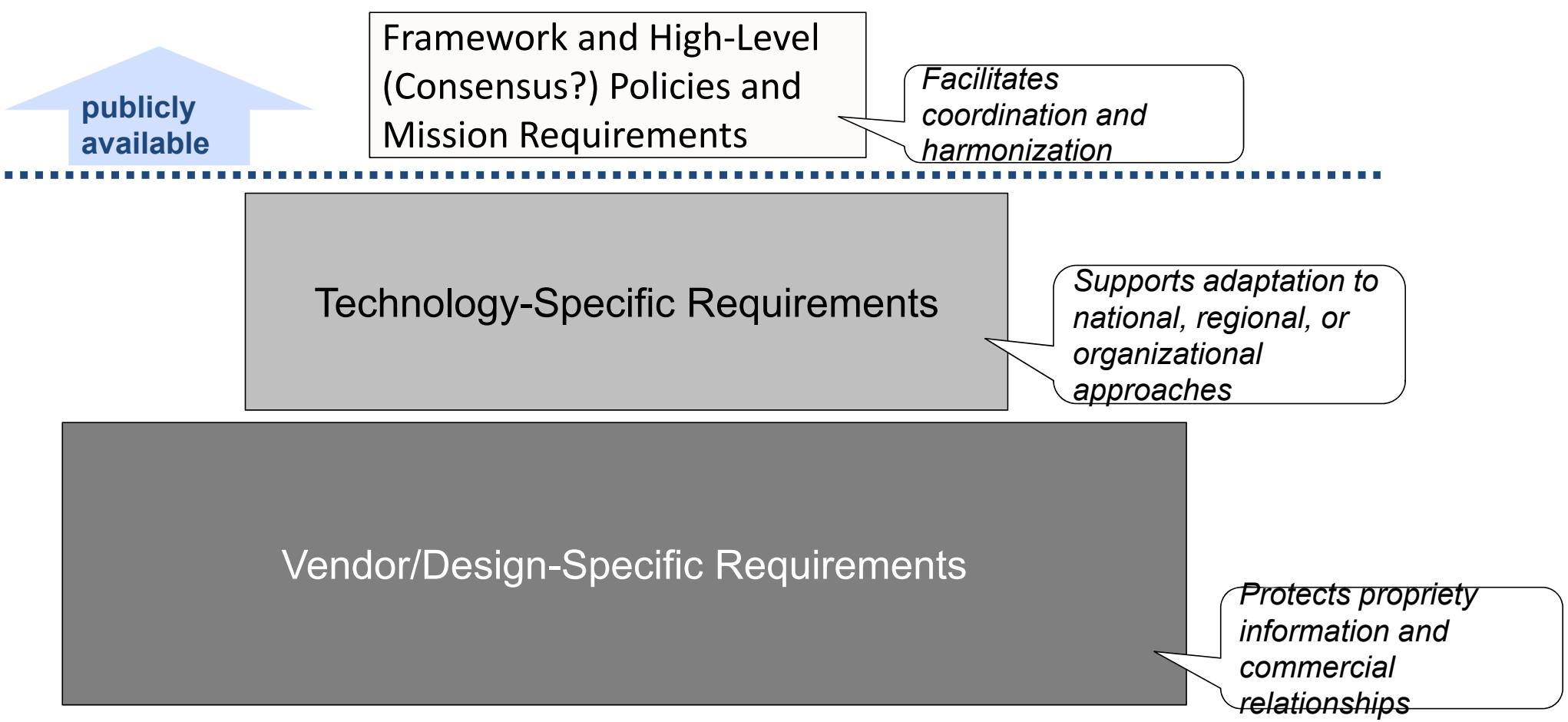


Planned ORG Rev. 2 Expansion in 2023

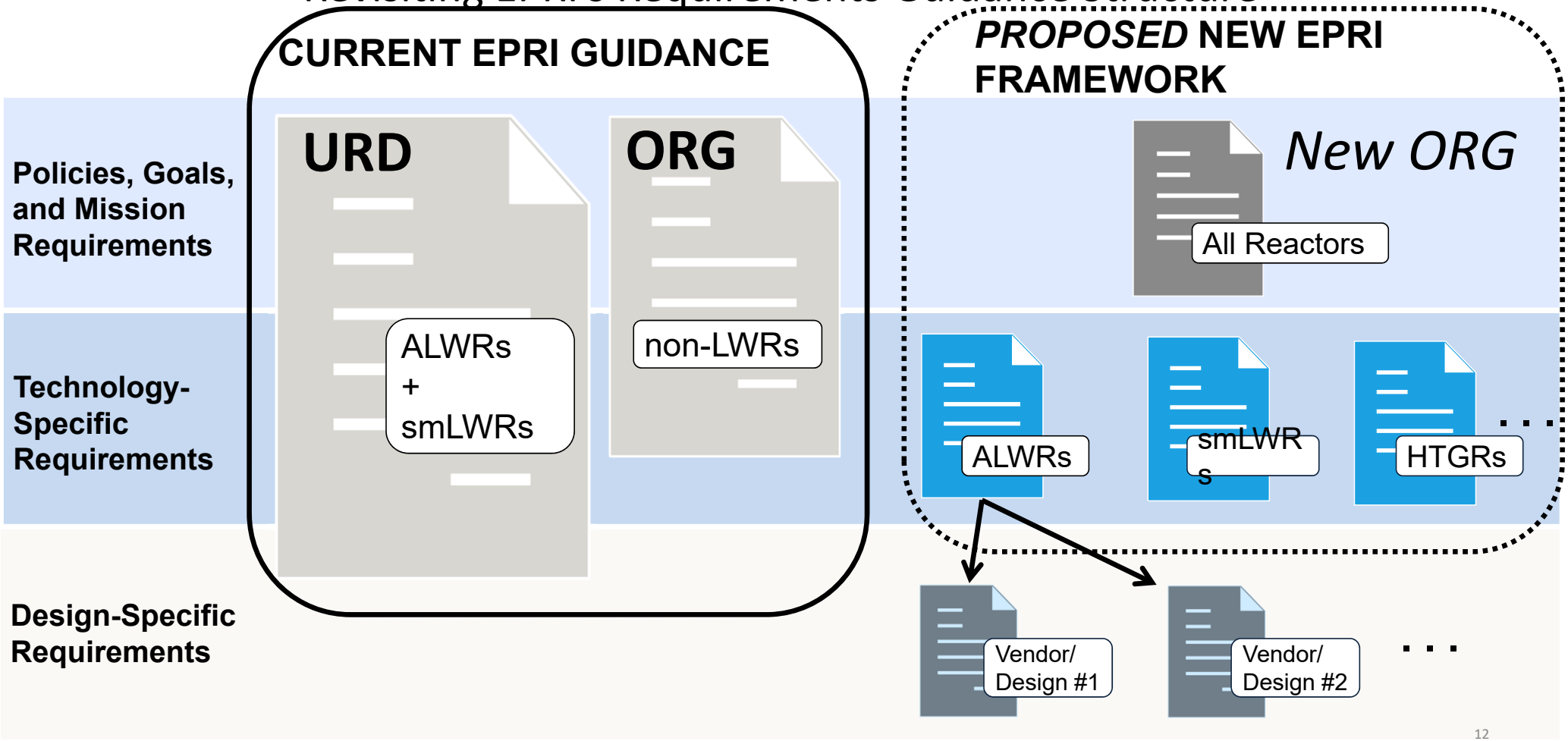

Currently a unique opportunity exists for international coordination and harmonization of end-user requirements for new (advanced) reactors.

A New Hierarchy to Support Harmonization

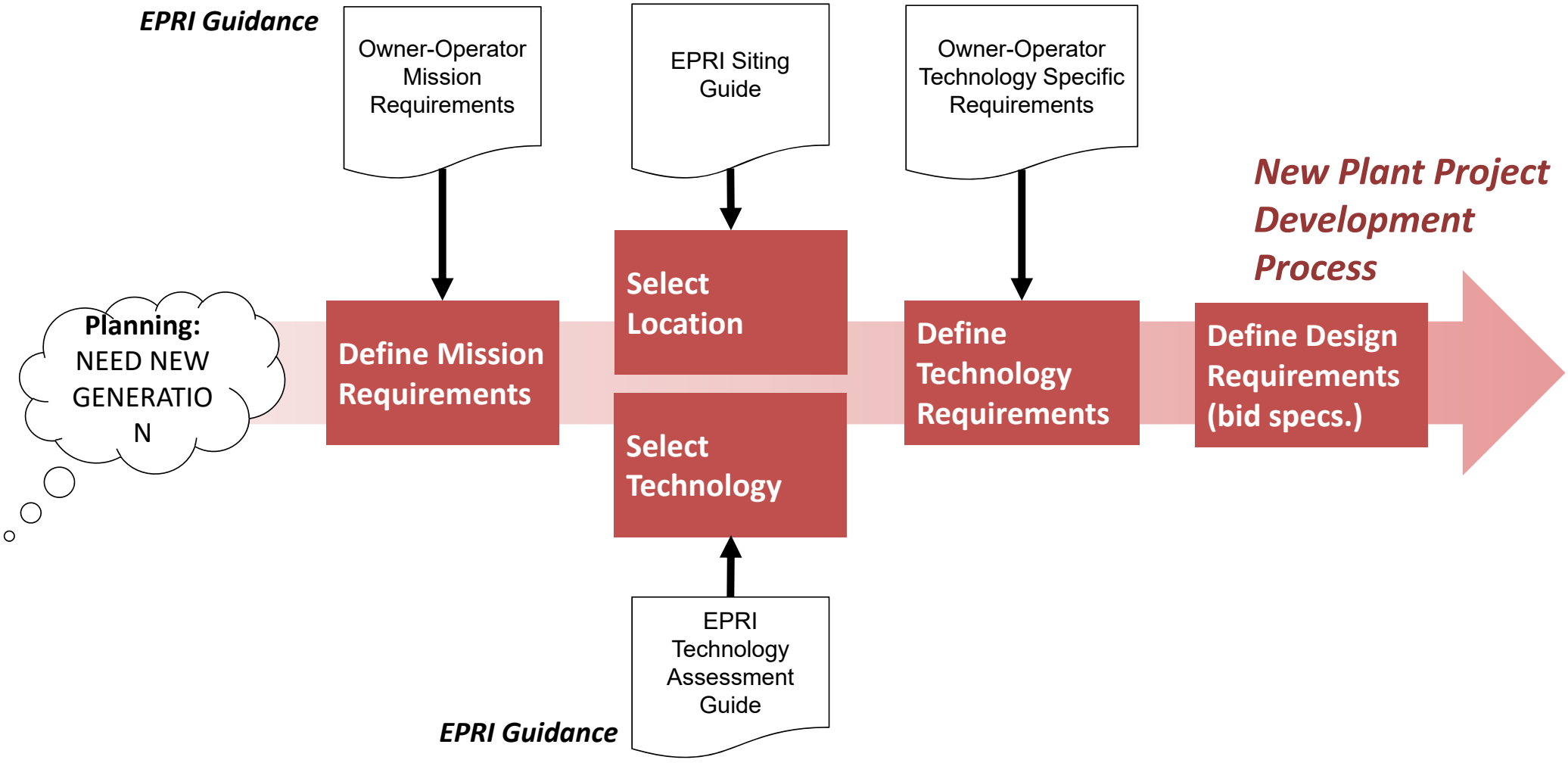
…while Preserving IP and Honoring Commercial Relationships



Revisiting EPRI's Requirements Guidance Structure



Project Development and Execution Paradigm

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Part 53 - Stakeholder Perspectives on Framework B, Framework A, and NRC Stakeholder Engagement Process
(Cyril Draffin, USNIC/ Marc Nichol)

Part 53 Rulemaking: General Part 53 Comments

(part of joint USNIC/NEI presentation)

NRC Advanced Reactor Stakeholder Meeting
30 June 2022

Cyril W. Draffin, Jr.
Senior Fellow, Advanced Nuclear
U.S. Nuclear Industry Council
Cyril.Draffin@usnic.org

Part 53 General Comments – Part 53 Not efficient

- Industry unanimous in wanting rule that is useful, efficient & technology inclusive
  - Concerned that (absent change) Part 53 will result in rule that few applicants wish to utilize-- applicants likely to seek exemptions to Part 50 and 52, which provides more predictable outcome without new requirements
  - Potential interest in using Part 53 is directly related to whether Part 53 will be more efficient than Parts 50 and 52 in achieving same level of safety

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Part 53 General Comments – Nuclear Energy Innovation and Modernization Act (NEIMA)

- "The purpose of this Act is … to allow the **innovation** and **commercialization** of advanced nuclear reactors" (Sec. 2)
  - Prescriptive language in Part 53 limits a designers' ability to be innovative, because they are locked into certain requirements regardless of variations in design considerations
  - Based on recent stakeholder input (USNIC/NEI survey) on the rule by those responsible for innovation/commercialization, not clear how the existing rule text supports innovation/commercialization
- "Staged licensing--For the purpose of predictable, **efficient**, and timely reviews" (Sec. 103. a (1)) and "improving the **efficiency**, timeliness, and cost-effectiveness of licensing reviews of commercial advanced nuclear reactors" (Sec. 103. b (4))
  - Not clear how Part 53 allows more efficient application preparation and review
  - Concerned that while well intended, current Part 53 framework is contrary to Congressional intent--by adding regulatory burden, making process less efficient, and not streamlining deployment of these technologies
- "Commission shall develop ….strategies for the increased use of **risk-informed, performance- based** licensing evaluation techniques and guidance for commercial advanced nuclear reactors" (Sec 103 a (2)) and "the Commission shall complete a rulemaking to establish a **technology-inclusive**, regulatory framework for **optional use** by commercial advanced nuclear reactor applicants for new reactor license applications." (Sec 103 a (4))
  - Many parts of Framework A and B are overly prescriptive

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Part 53 General Comments – Lengthy & Complex

- 397 page Part 53 Framework A + 304 page Framework B = **~700 pages**
  + other regulatory documents (e.g. Part 20)
    - Doubt that Congress, Industry, and the Public will think that more detailed regulations requiring hundreds of pages to present (more than current Part 50 and 52) adds clarity
    - We have not had enough time to conduct a detailed review the new >300 page Framework B
    - Some believe a single consolidated framework that utilizes guidance for details for different approaches would be more appropriate
    - We question whether long, detailed, prescriptive regulations is the "modernized" approach to regulations that the Commission is seeking?

Guidance documents (likely to be hundreds of pages, including 26 page Alternative Evaluation for Risk Insights (AERI)) will add to complexity

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Part 53 General Comments – Need RIPB language & clarity

Many prescriptive requirements in Framework A & B– many parts of Part 53 not risk-informed and performance-based (RIPB)

Where requirements are identical with Part 50 or 52– just reference them to avoid misalignment and adding unnecessary bulk in Part 53

- If QA closely aligned with 10 CFR Part 50 Appendix B, why not reference Part 50 Appendix B and list any necessary changes (and separately for clarity show changes in redline version and explain why changes made)

Part 53 approach and language may not reflect how licensing applications and analyses are done (using PRA as a tool and involving deterministic analysis)

- Too much separation in preliminary Part 53 language into different unconnected frameworks (e.g. Framework A, and multiple parts in Framework B) vs. allowing a continuous spectrum of probabilistic and risk-analysis approaches depending on the type of technology

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Part 53 General Comments - Which innovations NRC not pursuing would greatly enhance value of Part 53?

(score 0 to 5, with 5 being the most beneficial) (Q9 from April 2022 Industry Survey)

Part 53 Content	Most (4 or 5)	Least (0 or 1)	Don't Know
Streamlining of licensing reviews and regulatory approvals	**79%** (15)	0% (0)	5% (1)
Streamlining of program requirements	**68%** (13)	0% (0)	5% (1)
Treating ALARA as a Policy rather than requirements in the Rule	**67%** (14)	0% (0)	10% (2)
Streamlining of oversight and inspections	**65%** (13)	0% (0)	10% (2)
More performance-based and modern siting requirements	**60%** (12)	0% (0)	10% (2)
Integrating safety, security, emergency planning and siting	**57%** (12)	9% (2)	5% (1)
QA requirements that explicitly allow ISO-9001 for safety-related	**52%** (11)	0% (0)	10% (2)

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Part 53 General Comments – ALARA, DID, QHO, Programs

ALARA

- Our members recognize ALARA is a good practice, but Part 20 should be referenced, rather than putting new provisions in rule that affect design. How would including this in Part 53 interact with the Backfit Rule?

Defense in Depth

- DID is an important design philosophy. We suggest that the rule allow sufficient flexibility for applicants to demonstrate how DID is provided

QHOs (required in Framework A)

- Currently, there is no guidance on how to implement QHOs and we believe, as proposed by the staff, this is unnecessary expansion of regulatory requirements

Subpart F

- Some programs (e.g. Facility Safety program (53.890 in Framework A) and Integrity Assessment Program (53.850)) are redundant, new, and unnecessary- and value has not been explained

Other specific concerns in 5 Nov 2021 112-page NEI/USNIC document regarding Framework A

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High Level Insights for Framework A (relevant to Framework B)

- *Based on comprehensive April 2022 Industry survey*
  - *12 owner/ operator responses and 10 designer/developer-only responses*
  - *Key active organizations provided responses-- 15 of 22 respondents submitted application to NRC, are in pre-application with NRC, or submitted RIS response to NRC*

- Ten Part 53 items create significant concerns -- expanding ALARA to be design requirement, proliferation of unnecessary programs, increased regulatory burden for non-safety SSCs, safety objectives different than in AEA, expansion of design basis to include Beyond Design Basis Events, lack of clarity in purpose of some requirements, lack of measurable goals for regulatory efficiency
- Four Part 53 items have benefits -- increased use of performance-based approaches for security, technology-inclusive requirements, increased use of performance based approach for operators
- Most do not want QHOs in the rule -- All plan to use PRA
- Many goals for Part 53 are not met by current language: Improving regulatory efficiency, predictability, stability, clarity, and flexibility
- Part 53 review is time-consuming process; only limited support for current language; many areas where improvements needed to address concerns

Part 53 Going Forward

- In the past, Industry has given extensive input, but NRC staff usually has not been receptive to alternative approaches
  - NRC should offer alternative text for key issues (ALARA, PRA, QHO, DID, programs, etc.) for stakeholder/Commission review-- that encapsulates alternative positions provided by industry.
- Future Part 53 Public meetings could be changed from one-way NRC “listening sessions” to open two-way dialog leading to resolution of topical issues
- Rule should enable deployment of advanced technologies and not impose burdens currently **beyond** Part 50 and 52
  - **NRC bears responsibility for demonstrating why new requirements are required**. It should not be industry responsibility to demonstrate why new requirements should not be included.
  - NRC staff should **not** use this rulemaking to incorporate requirements in Part 53 that were **previously part of guidance documents**
  - Higher level standards and simplicity could benefit the process. Need reasonable balance between predictability and flexibility
  - NRC should be trying to make Part 53 more efficient t unfortunately added more burden)

Part 53 Rulemaking: Framework B

NRC Advanced Reactor Stakeholder Meeting

June 30, 2022

Marc Nichol, NEI
Senior Director, New Reactors

NUCLEAR ENERGY INSTITUTE

Context for Comments

- The following are initial thoughts based upon a cursory initial review of Part 53 Framework B. (ML22145A000)
- More detailed comments based upon a thorough review are being developed.

Part 53 Framework B – General Observations (1/3)

- The NRC "Part 53 Framework B Development Process and Provisions" White Paper is very useful in following the details in Framework B and in clearly identifying the provisions that come from Parts 50/52 and Framework A. Absent this document, sorting out the source for the requirements would be very challenging.
- Framework B is more technology-inclusive than Parts 50 and 52. However, much of the framework still appears to be LWR specific. There are numerous requirements that are still technology specific and prescribe the methods rather than establish the performance criteria.
- Rule text is very voluminous (over 300 pages). A streamlining of the rule text length will improve clarity, predictability and efficiency. Sources of this length appear to include 1) areas where rule language is duplicated with Parts 50/52 or Framework A, and 2) areas where requirement appears to have guidance level of detail (significantly more detail than equivalent types of requirements).

Part 53 Framework B – General Observations (2/3)

- Industry is unsure whether Framework B is viable, due to insufficient time to understand the details. Industry is cautious because significant detail has been observed in Framework B, and Framework A includes more regulatory burden than Parts 50/52.
- Some negative attributes of Framework A have been avoided in Framework B, such as not including a Facility Safety Program.
- Some positive attributes of Framework A were not included in Framework B, but should be. For example, the technology-inclusive and performance-based requirements for safety functions. These do not depend on the method in which a PRA is used, which NRC also stated at a public meeting in January 2022. Prescriptive requirements for safety functions will increase confusion, limit innovation, and increase the likelihood of needing exemptions.
- Some negative attributes of Framework A appear to be carried over, such as establishing requirements for the design to achieve ALARA, rather than an operational consideration as it is in Parts 50 and 52.
- Industry still believes it is possible to have a single Part 53 framework by not moving details appropriate for guidance into the rule text, and making simple changes in Framework A. Detail in the rule text will limit flexibility and is not necessary for regulatory clarity in predictability, since guidance can provide details.
  - November 5, 2021 recommended changes would result in a more viable rule.

Part 53 Framework B – General Observations (3/3)

- More effort is needed to develop an efficient rule through requirements that are performance-based and risk-informed.
    - Risk-informed and performance-based are independent concepts and the rule should have both.
- **Performance-based**:* A regulatory approach that focuses on desired, measurable outcomes, rather than prescriptive processes, techniques, or procedures. Performance-based regulation leads to defined results without specific direction regarding how those results are to be obtained. At the NRC, performance-based regulatory actions focus on identifying performance measures that ensure an adequate safety margin and offer incentives for licensees to improve safety without formal regulatory intervention by the agency.
    - Industry believes that Part 53 (Frameworks A and B) needs significant work in order to achieve a reasonable level of "performance-based".
- **Risk-informed**:* An approach to regulation taken by the NRC, which incorporates an assessment of safety significance or relative risk. This approach ensures that the regulatory burden imposed by an individual regulation or process is appropriate to its importance in protecting the health and safety of the public and the environment.
    - Note that this does not mean that requirements must prescribe the methods for utilizing quantitative PRA results in the safety case.

*Source: NRC Website

Part 53 Framework B – Specific Observations (1/4)

- **Draft Rule Text**: 53.4972(a)(5) “Mitigation of beyond-design-basis events”. This applies equally to 53.5019(a)(5)
  - The requirement points to 50.155, 50.155(b)(1) and 50.155(c) which are LWR-centric.
  - While including the mitigation provision is positive, the language in 53.4972(a)(5) should be modified to reflect a technology-inclusive, performance-based approach to mitigation for non-LWRs.
- **NEI proposed language** (adapted from NEI letter dated February 11, 2021)
  - Each applicant or licensee shall develop, implement, and maintain mitigation strategies and guidance for rare event sequences, which may include one or more reactor modules, and that are not expected to occur in the life of a nuclear power plant that are capable of being implemented site-wide and must include the following:
    1. The capability to maintain or restore the required facility functions necessary to meet the criteria in 53.2.
    2. The acquisition and use of offsite assistance and resources to support the functions required by paragraph (b)(1) of this section indefinitely, or until sufficient site functional capabilities can be maintained without the need for the mitigation strategies
    3. Strategies and guidance to provide the capabilities in (b)(1) under the circumstances associated with loss of large areas of the plant impacted by the event, due to explosions or fire, to minimize radiological releases.
- **Recommendation**: NRC consider including performance-based language similar to the proposed alternative

Part 53 Framework B – Specific Observations (2/4)

- **Draft Rule Text**: 53.4370(a)(3) - ALARA Requirement
  - *"As required by Subpart B to 10 CFR part 20, a combination of design features and programmatic controls must, to the extent practical, be based upon sound radiation protection principles to achieve occupational doses that are as low as is reasonably achievable."*
- **Current Regulation**: Part 20 Subpart B requirement, 20.1101 "Radiation Protection Programs"
  - "(b) The licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA)."
- **Problem**: Part 53 is not consistent with Part 20.
  - Is not applicable to the design features of the facility, and as they apply to the licensing of a new facility, focus solely on programs; and even when engineering controls are specified they refer to those used in the programs, not the design of the facility.
  - This requirement reduces clarity and predictability since it requires something that is not required in Part 20.
- **Recommendation**: Make Part 53 consistent with Part 20 by 1) deleting 53.4370(a)(3) or 2) matching Part 20 Subpart B verbatim.

Part 53 Framework B – Specific Observations (3/4)

- Examples of requirements that are prescriptive and not performance-based:
  - The Fire Protection requirements in 53.4350:
    - Appears to be more detailed and prescriptive than 50.48
    - Part 50 App. R. 53.4350 should be revised to make it performance based, with the details left to guidance.
    - An optional link to 50.48 and Part 50, App. R could be incorporated for applicants that do not want to make use of a performance-based regulation.
  - The requirements in 53.4380 “Environmental qualification of electric equipment important to safety for nuclear power plants”:
    - Includes the detailed and prescriptive requirements from 50.49.
    - This language should be revised to make the requirement performance based, leaving the detailed requirements to guidance.

Part 53 Framework B – Specific Observations (4/4)

- Subpart R – Operations Requirements
  - The option for a general license to the facility for operator training (released in latest Framework A Subpart F) should also be available for Framework B.
  - The general license for operator training should be optional, and not required. Some may meet the entry criteria, but have other reasons that they would not want to use a General License approach.

Alternative Evaluation of Risk Insights Guidance (1/2)

- Enabling an option to simplify the licensing-basis safety case by not requiring a PRA is a positive enhancement in Framework B.
- Although this results in a more conservative safety case, this may be attractive to some developers. Not just for micro-reactors, but for any that would be able to meet the entry criteria.
- The entry criteria of 1 rem at 100 meters appears to be overly conservative, and a more reasonable criteria could be established. This limit is influenced by the NRC assumptions for the event frequency and population density.
    - An event frequency of once per year to release 1 rem is overly conservative, and could be reduced to once in 100 years or less. The event frequency of higher consequence (1 rem) events are very rare, and the consequence of more frequent events will be much less than 1 rem. A more realistic consideration of frequencies and how they differ for different categories of events is needed to avoid excessive conservatism.
    - Population density will be site specific. The guidance should allow applicants to adjust the distance at which the 1 rem dose must be met based upon site specific factors.
    - The establishment of the bounding event is not clear and should be reasonable.

Alternative Evaluation of Risk Insights Guidance (2/2)

- The distance should not be specified in the entry criteria, but should be at the site boundary. Designs that use AERI are designs with very low potential consequences and will achieve an EPZ at the site boundary. Thus, whether the site boundary is 100 meters or 200 meters or something else, setting the 1 rem limit for AERI at the site boundary provides adequate protection of the public.
- The benefits of the AERI approach should be well defined:
    - NRC does not need to consider the PRA results in their review or in considering the Safety Goal Policy
    - Applicant does not need to meet requirements for BDBE mitigation
    - There may be other benefits, not yet considered
- NRC expressed that the AERI approach is not seen as lending itself to other risk-informed applications after initial licensing. This does not have to be the case, and options for future risk-informed applications should be explored.

Part 53 - Stakeholder Perspectives on Framework B, Framework A, and NRC Stakeholder Engagement Process (Rani Franovich, BTI/ Steve Nesbit, ANS)

Regulatory Priorities for New and Advanced Reactors
(Kati Augsten)

New Reactor Regulatory Priorities

Kati Austgen

June 30, 2022

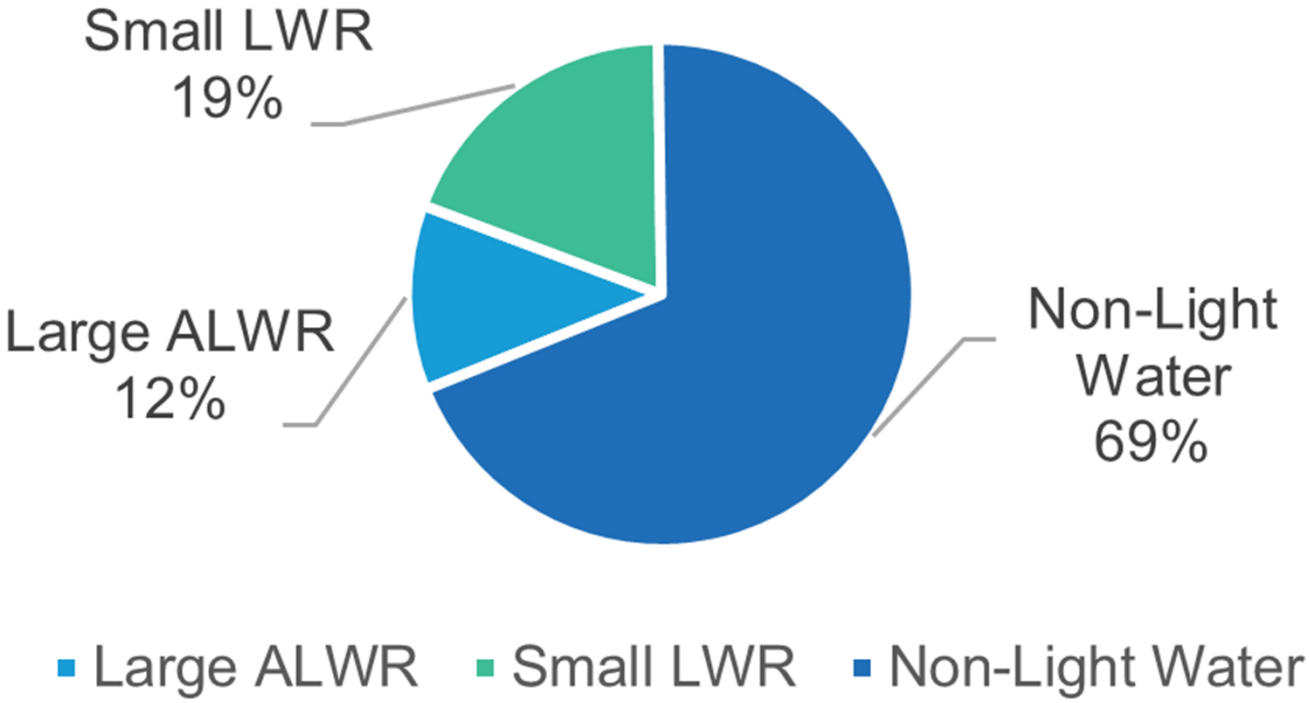
NUCLEAR ENERGY INSTITUTE

New Nuclear Demand

TO ACHIEVE OUR CLIMATE, ENERGY, ENVIRONMENTAL, ECONOMIC, AND NATIONAL SECURITY GOALS

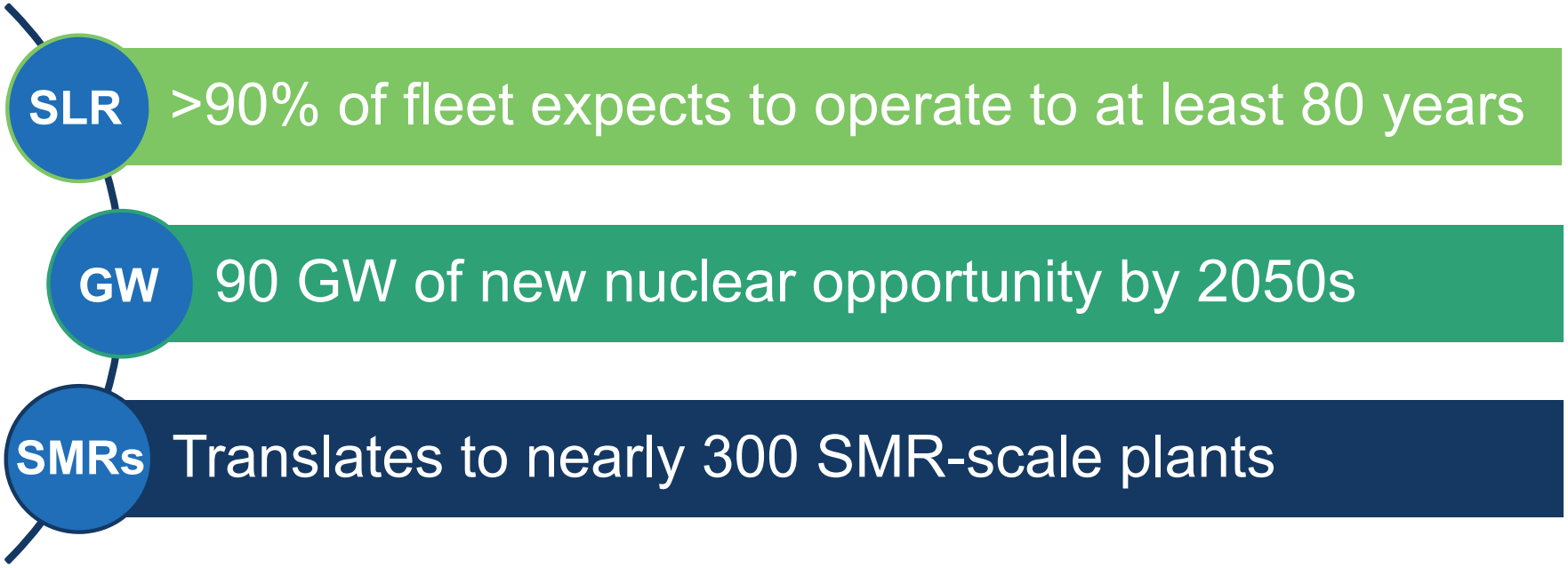
U.S. DOE Projection: >300 plants

2020-2050



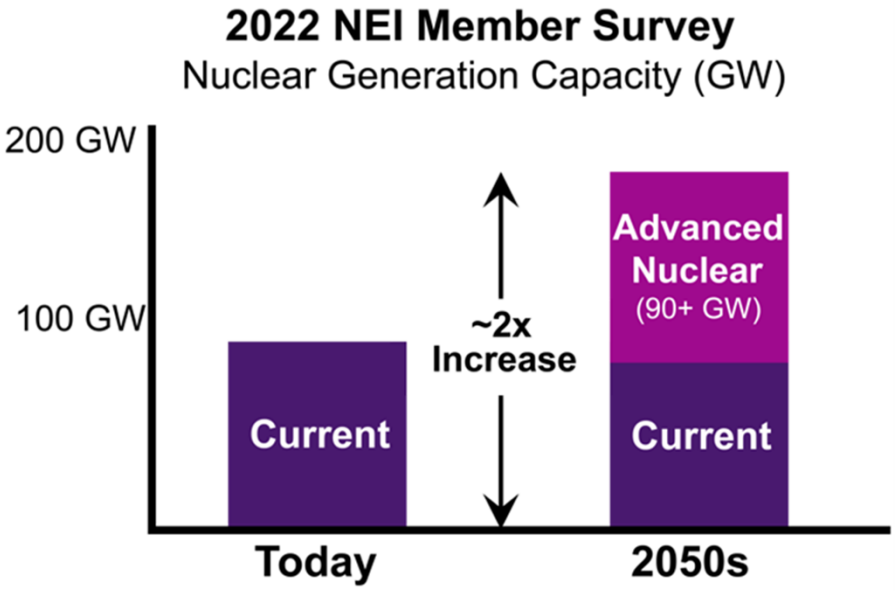
NEI Member Survey Top-Level Results

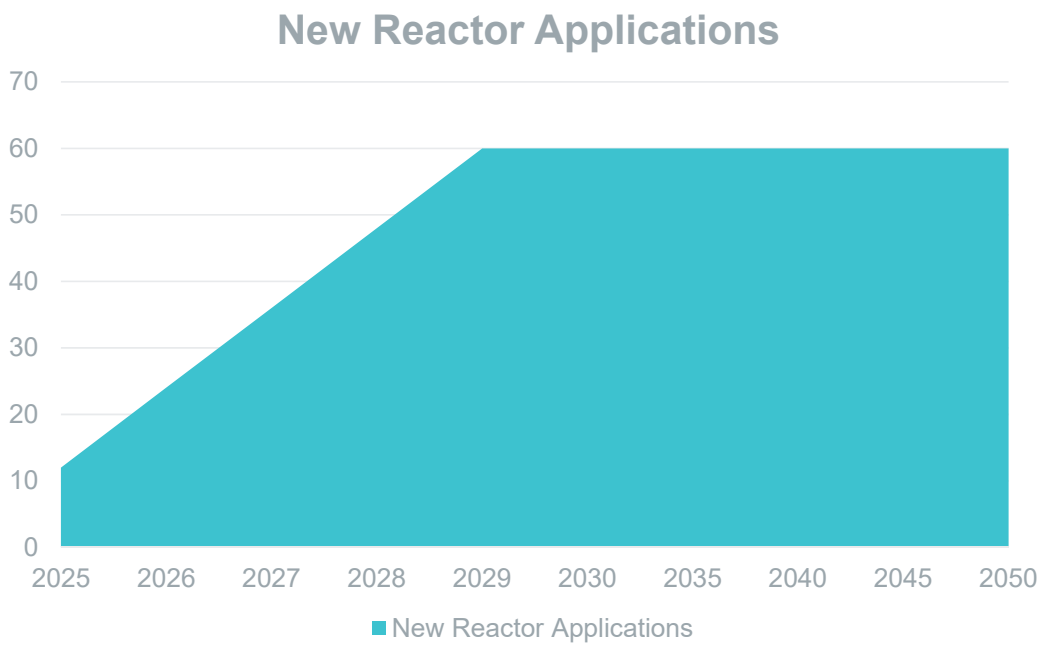
Nuclear power's potential role in meeting company decarbonization goals:



* NEI utility member companies produce less than half of all US electricity

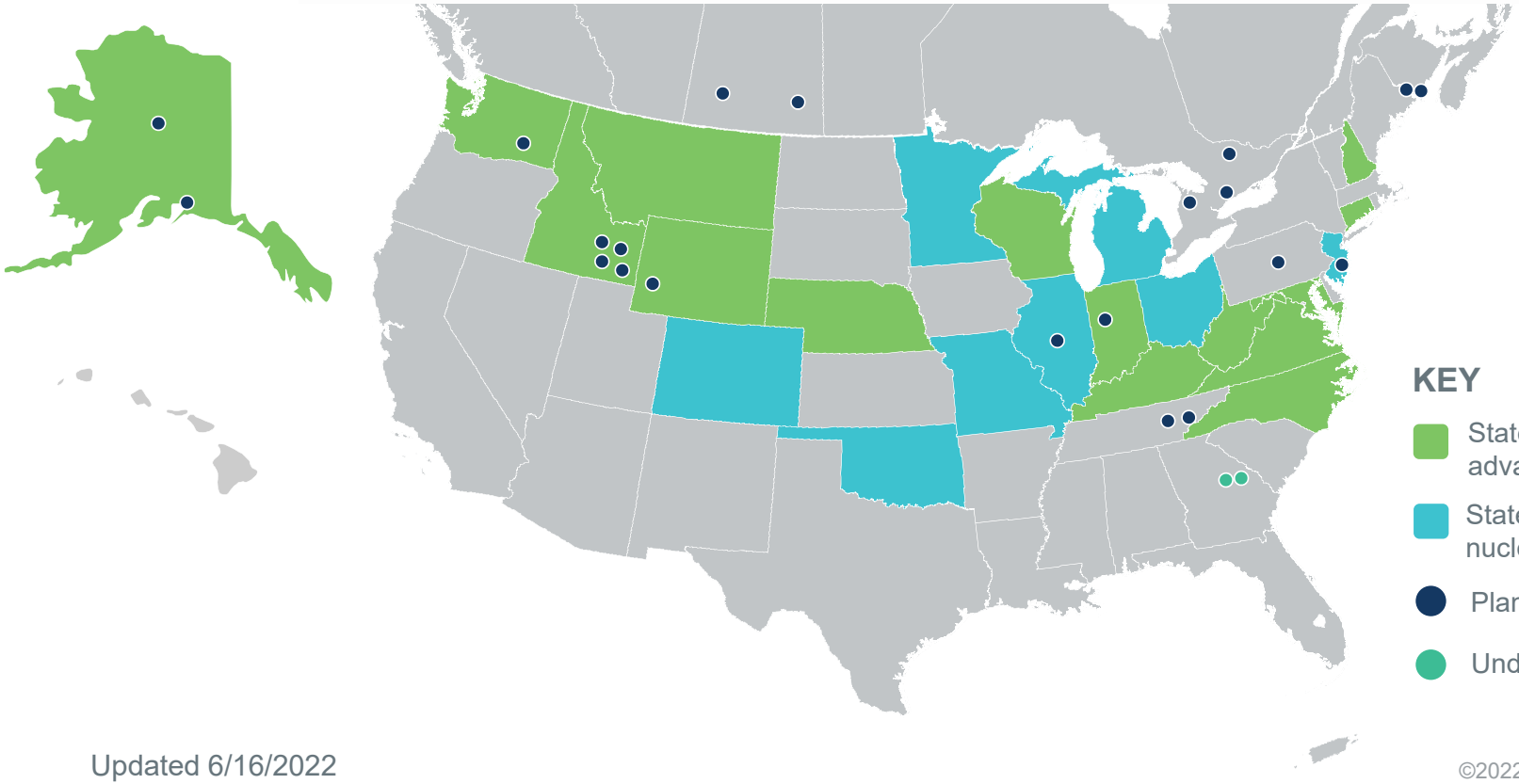
Potential Application Volume





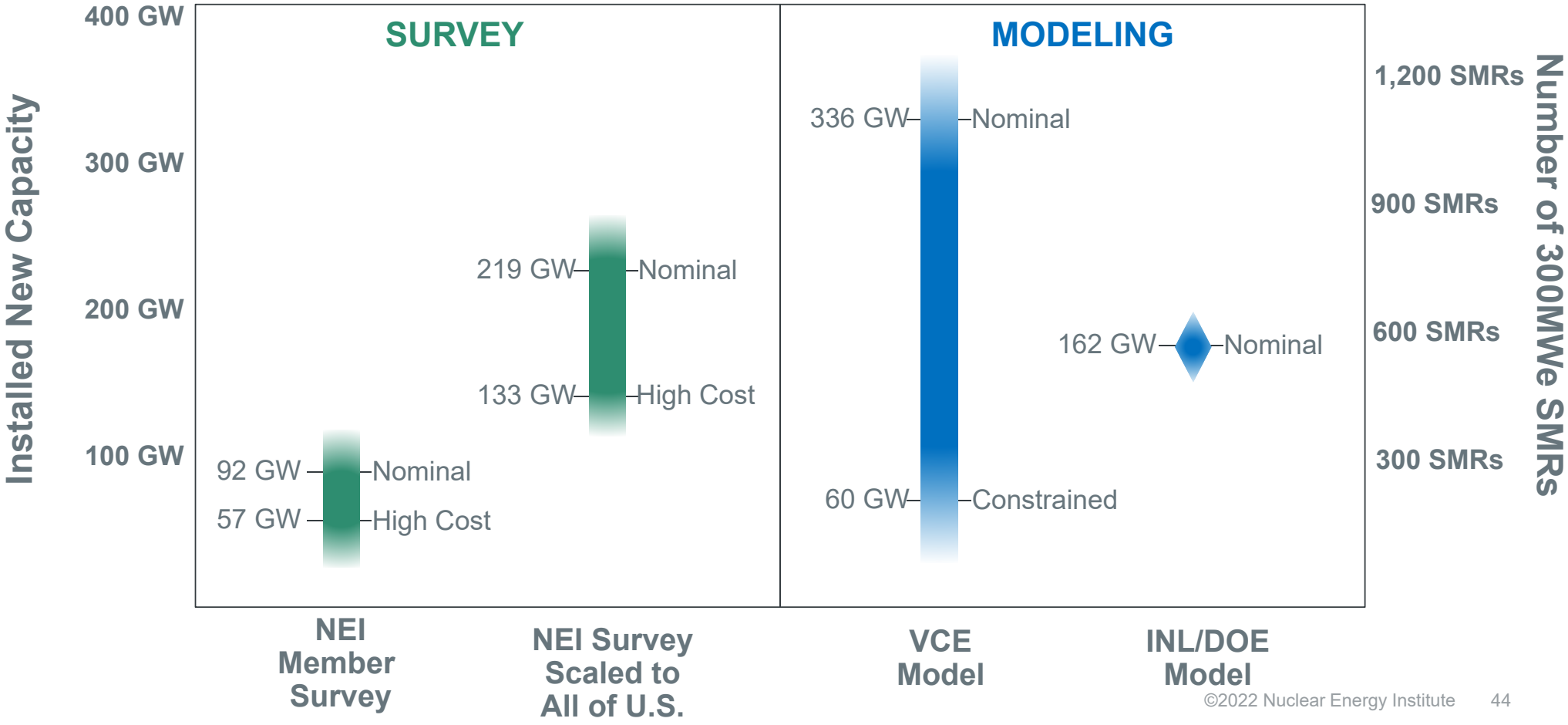
Advanced Nuclear Deployment Plans

Projects in planning or under consideration in U.S. and Canada >20; Globally >30



Updated 6/16/2022

Summary of Nuclear Demand to Support Decarbonization by the 2050s – Grid Only



Regulatory Priorities

NEW AND ADVANCED REACTORS

Priority Topics (1/2)

1. NRC Review Efficiency
   - Timeliness
   - Content of Applications
2. Environmental Reviews
3. Physical Security
4. Emergency Preparedness
5. Near-Term Risk-Informed, Technology Inclusive Regulatory Guidance
6. Part 50/52 Lessons Learned Rulemaking

Priority Topics (2/2)

7. Part 53 Rulemaking
8. Annual Fees for Non-Light Water Reactors
9. Siting
10. Advanced Manufacturing Technologies
11. Fuel Qualification
12. Operations

Part 53 Subpart F Staffing Requirements
(Jesse Seymour)

10 CFR Part 53 Subpart F
Staffing, Personnel Qualifications, Training, and Human Factors (2nd Iteration)

June 30, 2022

Agenda

2:40pm – 4:00pm	Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors: 2nd Iteration Overview
4:00pm – 4:35pm	Questions

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Presentation Topics

- Overview of Key Changes to Subpart F under the 2nd Iteration
  - Addition of Engineering Expertise Requirement
  - Expansion of Load Following Allowances
  - Removal of Simulator HFE Testbed Requirement
  - Replacement of Certified Operator Framework
- Generally Licensed Reactor Operators
- Questions

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Key Changes to Subpart F under the 2nd Iteration

- 2nd iteration of Subpart F retains majority of requirements developed for the 1st iteration
- Some requirements have been relocated to more appropriate spots (e.g., grouping technical requirements)
- Most changes made for the second iteration of Subpart F were also mirrored in the contents of Subpart P for Framework B
- A summary of those major changes will be provided here

Overview of Key Changes (continued)

- Expansion of load following allowances
  - 53.725(b) and 53.740(e) - (f) requirements modified to expand load following to include process heat usage
- Removal of simulator HFE testbed requirement
- Specific change management for approved programs
- Addition of engineering expertise requirement
  - Staffing plan requirements of 53.730(f) modified to include providing engineering expertise to operators
- Certified operator provisions completely replaced with an all new generally licensed reactor operator framework

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Engineering Expertise

Staffing plans for § 53.730(f) must include a description of how "engineering expertise" will be available to support the on-shift operating personnel during all plant conditions

- For all types of Part 53 plants, regardless of licensed operator category and common to Subparts F and P
- Intended to assist the on-shift crew with uncertainties (i.e., situations not covered by training or procedures)
- Must have both a qualifying degree (or a PE license) and familiarity with facility operation
- Provides flexibility: could be met by someone filling a traditional STA role or by offsite engineering expertise

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Generally Licensed Reactor Operators (GLROs)

Under 2nd iteration of subpart F operator licenses now consist of general licenses and specific licenses.

- A specific license is issued to a named person and is effective upon approval by the Commission of an application filed pursuant to the regulations in this part and issuance of licensing documents to the applicant. Specific licenses are issued to ROs and SROs.
- A general license is effective without the filing of an application with the Commission or the issuance of licensing documents to a particular person. The general licensing of GLROs is addressed by the requirements of §§ 53.800 through 53.830.

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Generally Licensed Reactor Operators (continued)

- What types of facilities would have GLROs?
  - No operator action is needed to mitigate plant events and achieve acceptable accident performance
  - Defense-in-depth independent of operator action
  - Operators not significant factor in safety outcomes
- What role would GLROs fulfil?
  - Administrative functions historically done by an SRO; keeps facility in analyzed state within licensing basis
  - Conduct manual reactivity manipulations if needed
  - Supervise core alterations and refueling operations

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Generally Licensed Reactor Operators (continued)

- Only a single operator license level exists within the GLRO framework (analogous to the SRO level)
- Plants meeting the criteria for using GLROs would have to use GLROs in lieu of ROs and SROs for staffing
- Like ROs and SROs, the GLRO training program must also be derived from a systems approach to training
- Prescriptive staffing and capabilities for GLROs:
  - Continuous monitoring with continuity of responsibility
  - Monitor plant parameters, evaluate emergency conditions, initiate reactor shutdown, dispatch/direct ops & maintenance personnel, and implement E-plan

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Generally Licensed Reactor Operators (continued)

- 53.800 defines new class of plants using the design criteria previously developed for "certified operator" use
  - Establishing new class done to conform with AEA
- 53.805 establishes the responsibilities of facility licensees that use GLROs:
  - Maintain GLROs qualifications for responsibilities
  - Only GLROs may manipulate facility controls
  - Develop/implement/maintain Commission approved programs for GLRO training, exams, & proficiency
  - Ensure GLROs meet Part 26 & 73 requirements
  - Report names of all GLROs to the NRC annually
- 53.810 is the general license; it is granted provided that qualifications are established and maintained subject to restrictions. GLROs are subject to enforcement action.

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Generally Licensed Reactor Operators (continued)

- 53.815 covers GLO training, retraining, and proficiency provisions
  - Training programs must be derived from SAT
    - Includes performing reactivity manipulations
  - Initial examination on knowledge and abilities
  - Continuing training and requalification exams
  - Requirements for use of simulation facilities
  - Records must be available for NRC inspection
  - Must establish a GLRO proficiency program
  - No specific medical requirements for GLROs
- 53.830 covers expiration of the license for GLROs

Subpart F – Staffing, Personnel Qualifications, Training, and Human Factors Requirements

Specific Licensing (RO/SRO) versus General Licensing (GLRO)

Comparison of key aspects of the SRO/RO and GLRO frameworks:

Framework Aspect	RO / SRO	GLRO
Licensed operators with responsibility for administrative requirements	Yes	Yes
Licensed operators with role in event mitigation	Yes	No
NRC has legal authority to suspend or revoke license for violations	Yes	Yes
NRC approval of training & exam programs required?	Yes	Yes
NRC approval needed for exams, medical, simulator, renewals, terminations, and waivers?	Yes	No
Flexibility for requalification training & exam periodicity?	No	Yes

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Protecting People and the Environment

Final Discussion and Questions

U.S.-NRC-CNSC Memorandum of Cooperation: Joint Report, TRISO Fuel Qualification Assessment (Jeffrey Schmidt)

CNSC/NRC TRISO Qualification Assessment

Second Interim Report
Advanced Reactor Stakeholders Meeting

Kelly Conlon, Canadian Nuclear Safety Commission (CNSC)
Jeff Schmidt, U.S. Nuclear Regulatory Commission (NRC)

Memorandum of Cooperation (MOC)

- Generic Tristructural Isotropic (TRISO) qualification assessment is supportive of NRC/CNSC MOC (ML19275D578), Item 2

Area of Cooperation	TRISO Assessment
Development of shared advanced reactor and SMR [small modular reactor] **technical review approaches that facilitate resolution of common technical questions** to facilitate regulatory reviews that address each Participant's national regulations	Exercise the fuel qualification framework developed in Nuclear Energy Agency (NEA) report, "Regulatory Perspectives on Nuclear Fuel Qualification for Advanced Reactors," (ML22018A099) and NUREG-2246, "Fuel Qualification for Advanced Reactors" (ML22063A131)
Collaboration on pre-application activities to **ensure mutual preparedness to efficiently review** advanced reactor and SMR designs	Several proposed advanced reactor designs use TRISO fuel and reference the testing performed as part of the Advanced Reactor Fuel (AGR) program as documented in topical report EPRI-AR-1(NP)-A
Collaboration on research, training, and in the development of regulatory approaches to **address unique and novel technical considerations** for ensuring the safety of advanced reactors and SMRs	Final report will (1) provide evidentiary basis to support regulatory findings for items that are generically applicable to TRISO, (2) identify items that are design dependent, and (3) highlight areas where additional information and/or testing is needed

Assessment Team and Schedule

- Joint report from CNSC and US NRC
- UK regulator, Office for Nuclear Regulation (ONR) involved as an observer
- Technical support provided by Pacific Northwest National Laboratory (PNNL)
- Work plan:

CNSC/NRC Joint TRISO Fuel Assessment Project

Objective/Scope

CNSC and USNRC staff will work together to establish a common regulatory position on TRISO fuel qualification based on existing knowledge and to identify any potential analytical or testing gaps which would need to be addressed to enable TRISO use in advanced reactor licensing applications.

- Available on NRC advanced reactor website https://www.nrc.gov/reactors/new-reactors/advanced/international-cooperation/collaboration-with-canada.html

☑ **Task A, Project Planning**

- Timeline: Fourth Quarter 2021
- End Product: Initial project plan finalized with resources in place (PNNL contract awarded)

☐ **Task B, Draft Fuel TRISO Fuel Assessment Report**

- Timeline: Fourth Quarter 2021 through Fourth Quarter 2022
- End Product: Four interim draft reports. The final draft will be a comprehensive draft report addressing the goals within the fuel qualification framework from NEA report, "Regulatory Perspectives on Nuclear Fuel Qualification for Advanced Reactors," and NUREG-2246.

☐ **Task C, Finalize Report**

- Timeline: Fourth Quarter 2022 to Second Quarter 2023
- End Product: The final report will be a joint NRC/CNSC report providing a generic assessment of TRISO fuel

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Input

ML21175A152

PNNL-31427

TRISO Fuel: Properties and Failure Modes

June 2021

IAEA-TECDOC-1645

TECDOC-1645

High Temperature Gas Cooled Reactor Fuels and Materials

ML20336A052

INTERNATIC

Framework

ML22018A099

NEA/CNRA/R(2020)1

Unclassified English text only

NUCLEAR ENERGY AGENCY

COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

NUREG-2246

Regulatory Pers
Fuel Qualificatio
Reactors

Fuel Qualification for Advanced Reactors

Final

ML22063A131

Technical Report of the CNRA Wor

Office of Nuclear Reactor Regulation

Interim Report

ML22101A297

Focus of Second Interim Report – NUREG-2246 Goals

GOAL	Fuel is qualified for use			
G1	Fuel is manufactured in accordance with a specification			
	G1.1	Key dimensions and tolerances of fuel components are specified		
	G1.2	Key constituents are specified with allowance for impurities		
	G1.3	End state attributes for materials within fuel components are specified or otherwise justified		
G2	Margin to safety limits can be demonstrated			
	G2.1	Margin to design limits can be demonstrated under conditions of normal operation and AOOs		
		G2.1.1	Fuel performance envelope is defined	
		G2.1.2	Evaluation model is available (see EM Assessment Framework)	
	G2.2	Margin to radionuclide release limits under accident conditions can be demonstrated		
		G2.1.1	Fuel performance envelope is defined	
		G2.2.1	Radionuclide retention requirements are specified	
		G2.2.2	Criteria for barrier degradation and failure are suitably conservative	
			(a)	Criteria are conservative
			(b)	Experimental data are appropriate (see ED Assessment Framework)
		G2.2.3	Radionuclide retention and release from fuel matrix are modeled conservatively	
			(a)	Model is conservative
			(b)	Experimental data are appropriate (see ED Assessment Framework)
	G2.3	Ability to achieve and maintain safe shutdown is assured		
		G2.3.1	Coolable geometry is ensured	
			(a)	Criteria to ensure coolable geometry are specified
			(b)	Evaluation models are available (see EM Assessment Framework)
		G2.3.2	Negative reactivity insertion can be demonstrated	
			(a)	Criteria are provided to ensure that negative reactivity insertion is not obstructed
			(b)	Evaluation model is available (see EM Assessment Framework)

Focus of Second Interim Report – NUREG-2246 Goals (cont)

GOAL	Evaluation model is acceptable for use		
EM G1	Evaluation model contains the appropriate modeling capabilities		
	EM G1.1	Evaluation model is capable of modeling the geometry of the fuel system	
	EM G1.2	Evaluation model is capable of modeling the material properties of the fuel system	
	EM G1.3	Evaluation model is capable of modeling the physics relevant to fuel performance	
EM G2	Evaluation model has been adequately assessed against experimental data		
	EM G2.1	Data used for assessment are appropriate (see ED Assessment Framework)	
	EM G2.2	Evaluation model is demonstrably able to predict fuel failure and degradation mechanisms over the test envelope	
		EM G2.2.1	Evaluation model error is quantified through assessment against experimental data
		EM G2.2.2	Evaluation model error is determined throughout the fuel performance envelope
		EM G2.2.3	Sparse data regions are justified
		EM G2.2.4	Evaluation model is restricted to use within its test envelope

Interim Report - Contents

- Release paths from TRISO fuel identified
- Safe state considerations including maintaining a coolable geometry and allowing for negative reactivity insertion when needed
- Evaluation model and capabilities

Interim Report - TRISO Release Paths

- Releases from fission of tramp uranium
- Releases from fabrication-induced particle defects
- Releases from particles that fail during normal operation
- Releases from particles that fail because of the accident
- Releases from the increase in permeability of the TRISO layers

Interim Report - Safe State

- As described in Fuel Qualification for Advanced Reactors (NUREG-2246), fuel assemblies or fuel structures geometric stability can be important to retaining a coolable geometry and the ability to insert negative reactivity under accident conditions.
- For most TRISO fueled designs, these requirements are achieved by maintaining pebble or compact integrity or are not dependent on the fuel design (e.g., control elements inserting into a graphite block).
- Fuel pebble/compact integrity is material and environment dependent and hence typically addressed on a design dependent basis (e.g., molten salt coolant).
- For compacts made consistent with the AGR program specification, operation in a noble gas environment up to 1800 C is acceptable.
- Next interim will report planning to add information on acceptable pebble matrix material when operating in a noble gas environment.

Interim report - Evaluation Model and Capabilities

- Evaluation models can be computer codes, hand calculations or experimental data
- Evaluation models need to consider particle geometry and material properties changes with burnup and the thermofluid models used to determine compact/pebble boundary conditions
- Evaluation models used to determine radionuclide release should be benchmarked to appropriate experimental data per NUREG-2246, Section 3.4
- In-service intact releases and coatings failures are primarily driven by temperature, hence system/TRISO particle temperatures should be conservatively determined
- Currently, evaluation models are expected to be design/applicant specific

Goals for Third Interim Report

- Expand particle manufacturing section to include discussion of coating process and SiC microstructure attributes which ensure adequate fission product retention
- Expand information on fuel element matrix material which has demonstrated the ability to maintain TRISO particle integrity and support maintaining a safe state
- Continue work on the evaluation models used to predict radionuclide release
- Begin drafting the experimental data assessment section (NUREG-2246, Section 3.4)

Questions?

(Questions for CNSC should be directed to **mediarelations-relationsmedias@cnsc-ccsn.gc.ca** or by phone at 613-996-6860)