Advanced Reactor Stakeholder Public Meeting

October 25, 2023

Microsoft Teams Meeting

Bridgeline: 301-576-2978

Conference ID: 435 901 348#

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

Time	Agenda	Speaker
10:00 am – 10:10 am	Opening Remarks	NRC
10:10 am – 10:15 am	Advanced Reactor Integrated Schedule	NRC
10:15 – 10:45 am	Status of Draft Seismic Regulatory Guides DG-1410 and DG-1307	NRC
10:45 – 11:15 am	Standard Design Approvals for Construction Permit and Operating License Applications	NRC
11:15-11:20 am	Fuel Cycle Activities Supporting Advanced Reactor Deployment	NRC
11:20-11:30 am	BREAK	
11:30-11:35 am	Upcoming Regulatory Information Conference Workshop on National Nuclear Security Administration 3S (safety, security, and safeguards) Principles	NRC
11:35-12:00 pm	Metallic Fuel Qualification	NRC
12:00-1:00 pm	LUNCH BREAK	
1:00 – 1:50 pm	International Regulatory Efficiency	NEI

Time	Agenda (Continued)	Speaker
1:50-2:00 pm	Announcement on ASME Section III Executive Strategic Advisory Counsel	NEI
2:00-2:10pm	Public Comments	
2:10-2:15 pm	Planning for Next Meeting and Closing Remarks	NRC
2:15 pm	Adjourn	

NRC's Advanced Reactor Readiness By the Numbers

ADVANCED REACTOR READY U.S.NRC

Work on more than **35 policy issues** created more than **60 guidance documents**.

Completed more than **10 advanced reactor design** reference models to make future assessments more efficient.

Completed more than **90 topical report/ white paper reviews 33% faster** than the generic schedule goal.

10 NRC/DOE MOUs focused on advanced reactor collaboration.

Completed Kairos construction permit safety review **50% faster** than the generic schedule goal.

Canada collaboration generated more than **10 work plans, 8 NRC/CNSC joint reports.**

Focusing on core review teams of **8-10 technical staff** per application, based on recent new reactor review experience.

More than **140 public engagements** per year on advanced reactor-related topics

As of October 2023

Advanced Reactor Integrated Schedule of Activities (Slide 1 of 2)

- Micro-Reactor Policy
  - Updated draft white paper, "Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory," released to public on Sept. 27 (Revised Draft White Paper: ML23264A802, Enclosure: ML23264A803) prior to ACRS briefing held on Oct. 3
  - SECY paper publication expected in the near future

- Material Compatibility Interim Staff Guidance – publication of final version expected this calendar year

- Draft Regulatory Guide (DG)-4034 (RG 4.7, Rev. 4), "General Site Suitability Criteria for Nuclear Power Stations"
  - Publication on Oct. 12 (ML23123A090) & related public meeting on Oct. 27
  - *Federal Register* Notice for public comment published on Oct. 18, with comments due by Nov. 17, 2023

Advanced Reactor Integrated Schedule of Activities (Slide 2 of 2)

- Kairos Power, LLC (Kairos) Hermes 1 Construction Permit Application Review – hearing on Oct. 19
- Kairos Power, LLC Hermes 2 Construction Permit Application Review
  - Application Docketing Decision Letter issued/Acceptance Review complete on Sept. 11
  - SECY-23-0080, "Environmental Review Approach for the Kairos Power, LLC Hermes 2 Construction Permit Application" released to public on Sept. 27
- Advanced Reactor Content of Application Project (ARCAP)/Technology Inclusive Content of Application Project (TICAP) Guidance Documents – Advisory Committee on Reactor Safeguards (ACRS) briefing on Nov. 16 (supporting documents for this meeting at ML23283A092)

Periodic Advanced Reactor Stakeholder Meeting: Status of Draft Regulatory Guides DG 1410 and DG 1307

Dr. John Stamatakos
Institute Scientist at Southwest Research Institute
October 25, 2023

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United States Nuclear Regulatory Commission
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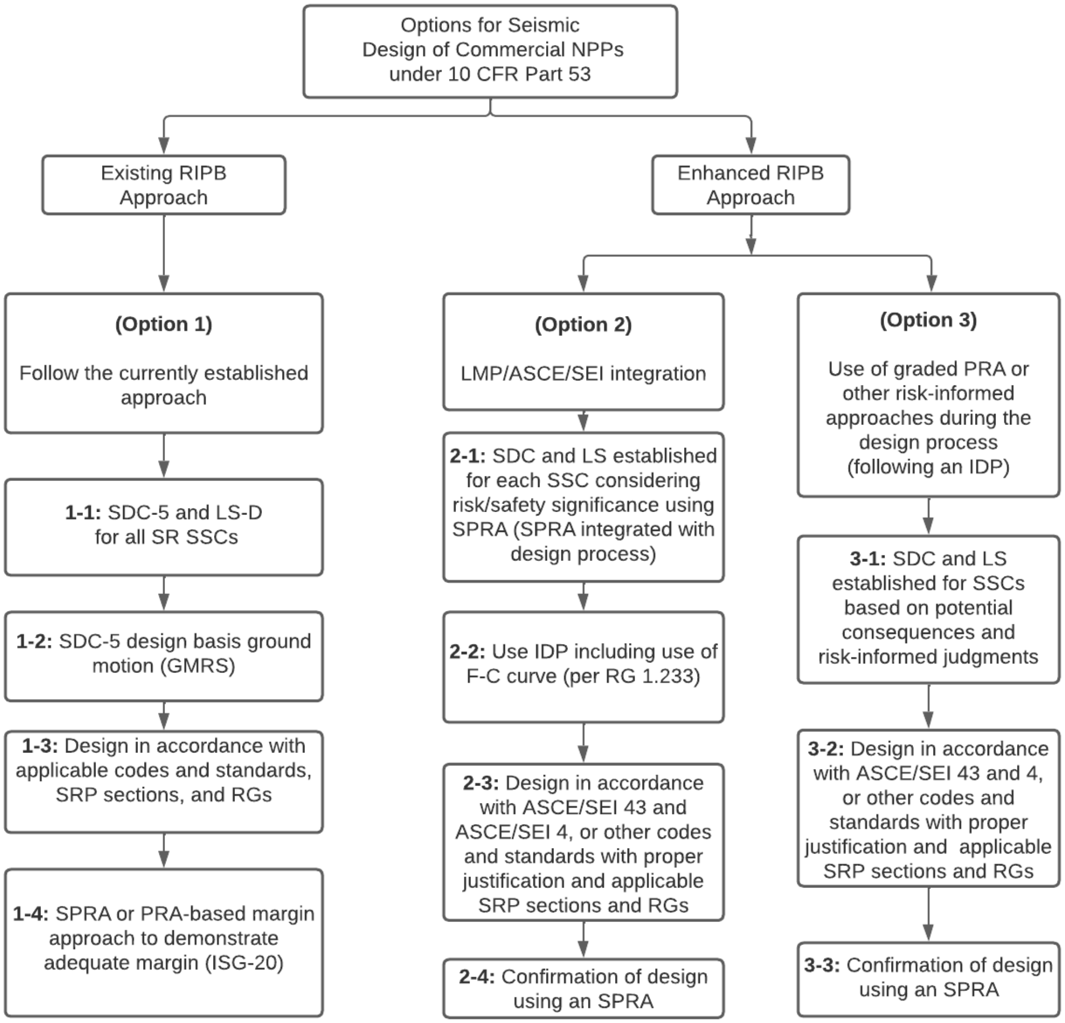
Overview

Changes since March 2023 Periodic Advanced Reactor Stakeholder Meeting

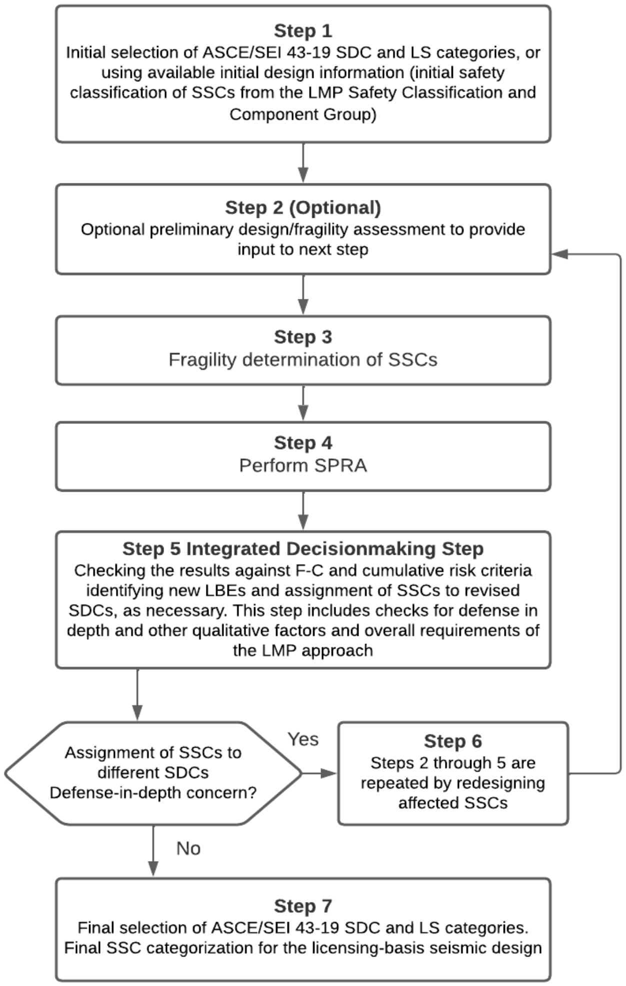
- DG 1410 (RG 1.251) "Technology Inclusive, Risk Informed, And Performance Based Methodology for Seismic Design of Commercial Nuclear Plants"
  - Current version addresses both Framework A and Framework B, consistent with the most recent version of 10 CFR Part 53
  - Three seismic design options for each Framework
  - Appendix A and Appendix B, each provides an example for Option 2 and Option 3 implementation, respectively
- DG 1307 (RG 1.252) "Seismically Isolated Nuclear Power Plants"
  - Minor changes
- Guides are in the NRC process for publication and for public comments.
- Future plans and summary

DG 1410 (RG 1.251) “Technology Inclusive, Risk Informed, And Performance Based Methodology for Seismic Design of Commercial Nuclear Plants”

Three Options

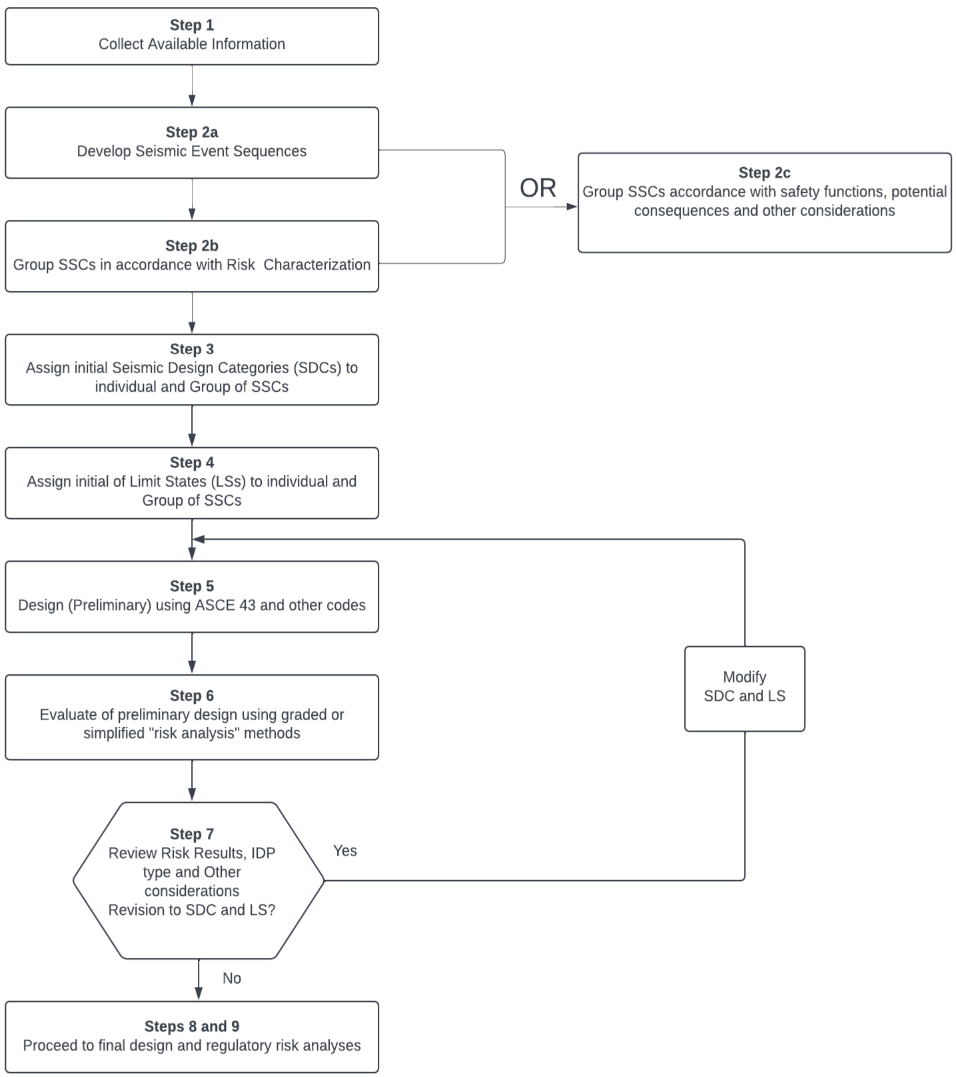


Appendix A: Example for Option 2 Implementation



Note: LBE = Licensing Basis Event

- Licensing Modernization Project (LMP)/American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI) Integration Approach
  - The example in Appendix A provides one approach to determine seismic design categories and design limit states for structures, systems, and components
  - Follows Research Information Letter (RIL) 2021-04, “Feasibility Study on a Potential Consequence Based Seismic Design Approach for Nuclear Facilities,” issued April 2021



Appendix B: Example for Option 3 Implementation

- Option 3 allows for a broader range of analyses to demonstrate seismic safety, including combinations of deterministic and probabilistic analyses based on realistic, approximate, bounding, or conservative analyses mixed with quantitative risk information

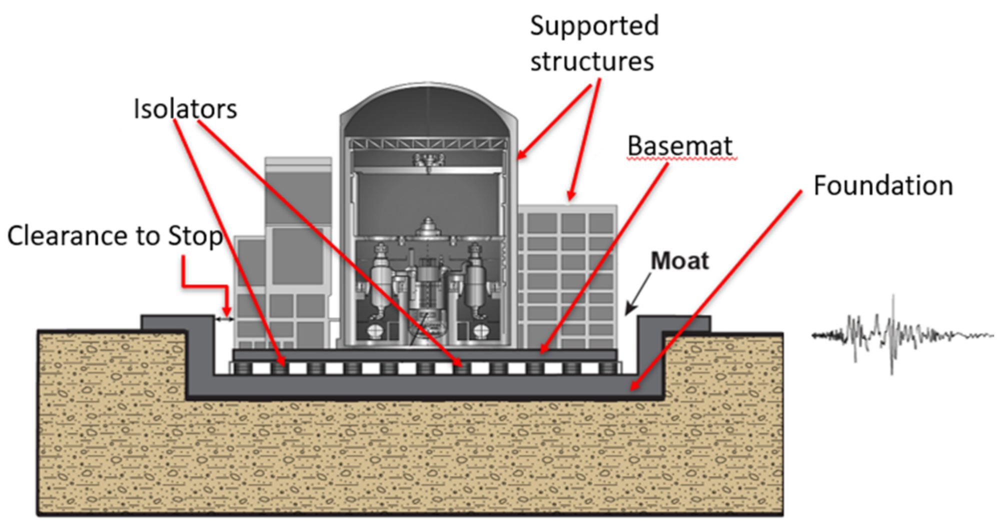
- Option 3 thus provides the most flexibility of all three options described in RG 1410 to determine and evaluate seismic design, performance, and risk in meeting the requirements of 10 CFR Part 53

- An important component in Option 3 is the application of an integrated decision-making process (IDP) that is performance-based and risk-informed

DG 1307 (RG 1.252) "Seismically Isolated Nuclear Power Plants"

– Technical considerations:

- Use the same technical approach as described in DG1410 (3 options)
- Focus on addressing SI specific criteria for each of the 3 options
- Guidance relies on ASCE 43-19 and ASCE 4-16 as well as available literature



Plans and Schedule

- Both Draft RGs are undergoing NRC regulatory guide publication process, with planned publication for public comments in Q2 of FY24
- A NUREG/CR that documents the technical basis and implementation considerations is under preparation. This will be a companion document to RIL 2021 – 04.

NRC Staff Draft White Paper
Development of New Reactor Application Standard Content to Support Timely, Efficient, and Effective Reviews of Subsequent Applications

Presenter: Joseph Colaccino

Other Contributors: Belkys Sosa, Joseph Sebrosky, Nanette Valliere, John Segala, Amy Cubbage, Steve Lynch, Michelle Hayes, NRC OGC

25 Oct 2023

Purpose

- Provide draft high-level guidance for the development of standard content for future applications for reactor licenses
- Identify standard content in the OL FSAR and migrating that information to a standard design approval application
- Use the design centered review approach to effectively develop applications that will contain standard content that has been approved in a previous NRC review

➢ Site-specific environmental review is not discussed in the draft white paper

Standard Content

- Standard content: design information that will be identical at every site
- Construction permit: preliminary design and site-specific information
- Operating license: final safety analysis report
- Standard design approval: final safety analysis report that describes facility, design bases and limits on operation, safety analysis of structures, systems and components or major portions

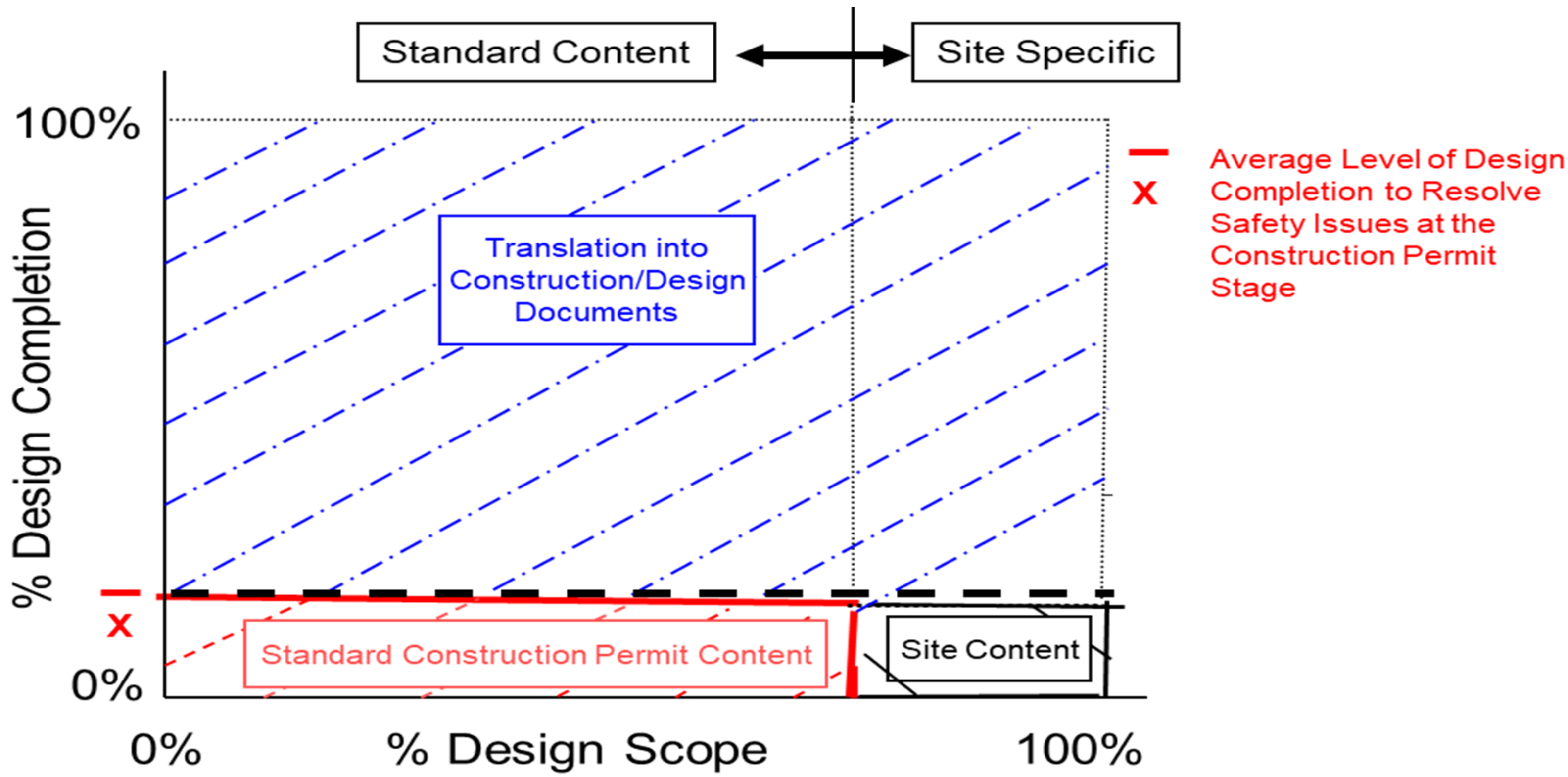


Figure 1: Construction Permit Application

The areas on the figure do not represent the relative quantity of each type of information necessary for an application

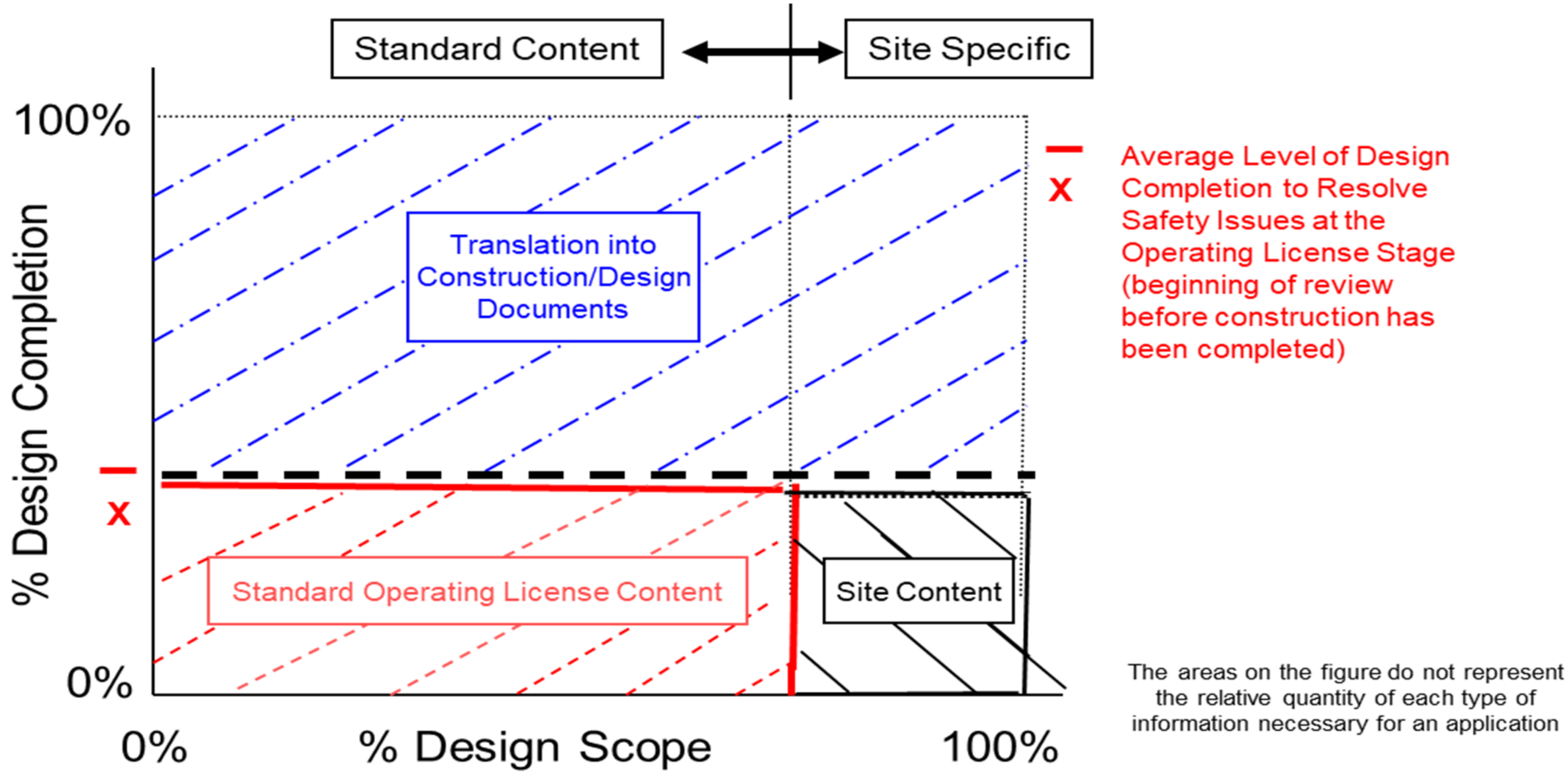


Figure 2: Operating License Application

Using the Final Safety Analysis Report Approved in the Operating License as the Basis for the Standard Design Approval

- Version of the Updated FSAR (UFSAR) for a facility for which the Commission has granted an OL in effect six months before submission of the SDA application

- Scope of the standard design approval
  - ➢ all the SSCs that would be identical at every facility constructed, including the interfaces between the standard design and the balance of the nuclear power plant

  - ➢ site information, such as postulated site parameters to determine if the approved design can be located at a specific site

The Design-Centered Review Approach (DCRA)

- Formation of an industry-led design center working group comprising the vendor of a reactor design and prospective entities developing licensing applications

- Engaged design center has the potential to efficiently identify standard content and effectively migrate this information into subsequent applications

- Regulatory Guide 1.206, Revision 1, section C.2.7, provides guidance for implementing the DCRA

- Referencing approach associated with the DCRA involves the use of left-margin annotations in the FSAR
  - Design Center can develop their own preferred approach

Using the Design-Centered Review Approach for a Reference Construction Permit and Operating License

- Vendor and prospective applicants should inform the NRC as early as possible that they are going to form a design center
- Upon OL issuance, the standard information in the FSAR becomes the basis for development of the standard design approval application
- Associated licensing activities could be done in series or parallel
- Design center can decide to forgo development of a standard design approval

Next 3 slides provide examples of scenarios discussed above

Figure 3: Construction Permit/Operating License to Standard Design Approval and Subsequent CP and COL

Use of Design Centered Review Approach

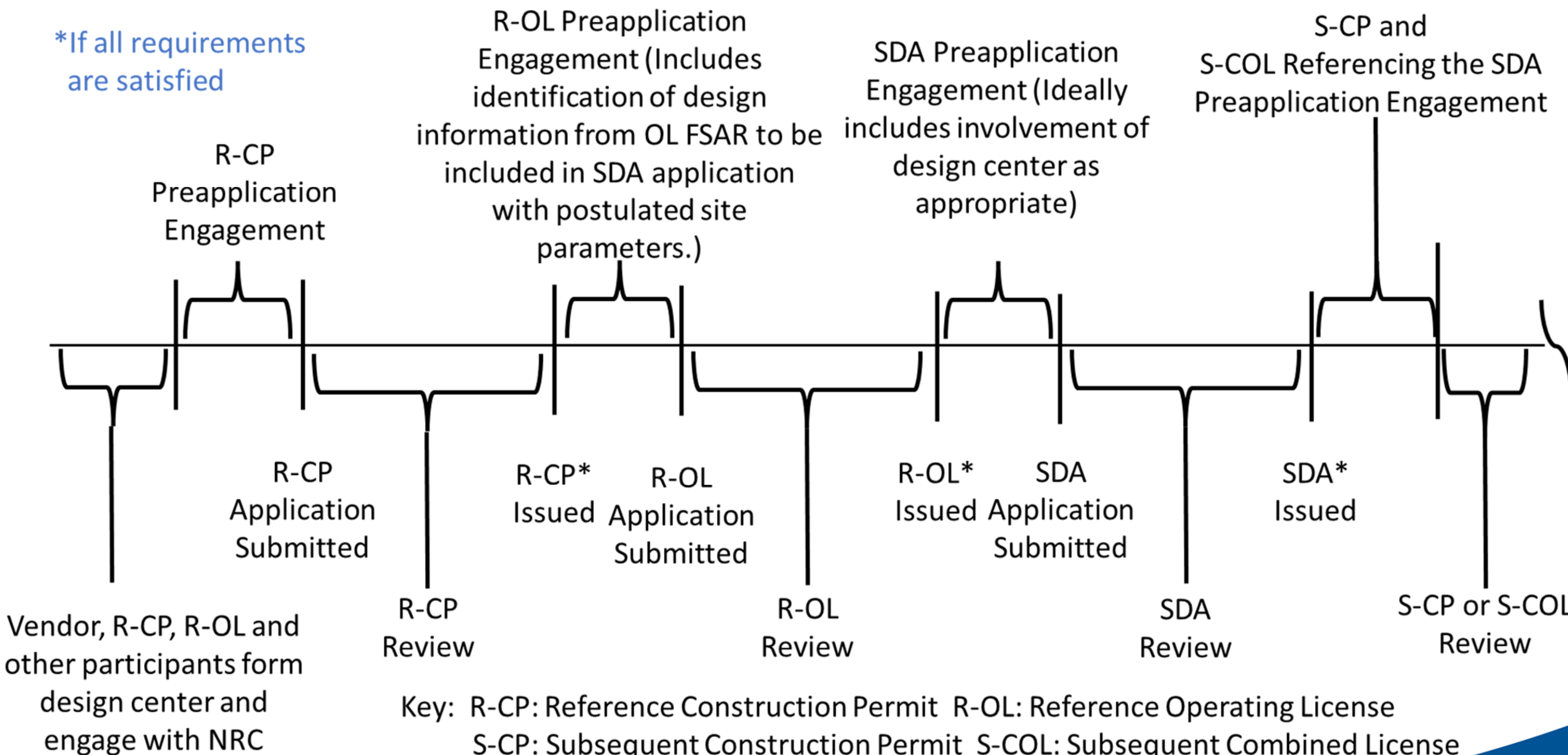


Figure 4: Construction Permit/Operating License to Standard Design Approval and Subsequent CP and COL

R-OL Schedule Overlaps with Preapplication Engagement, SDA Schedule and S-CP and S-OL Schedules

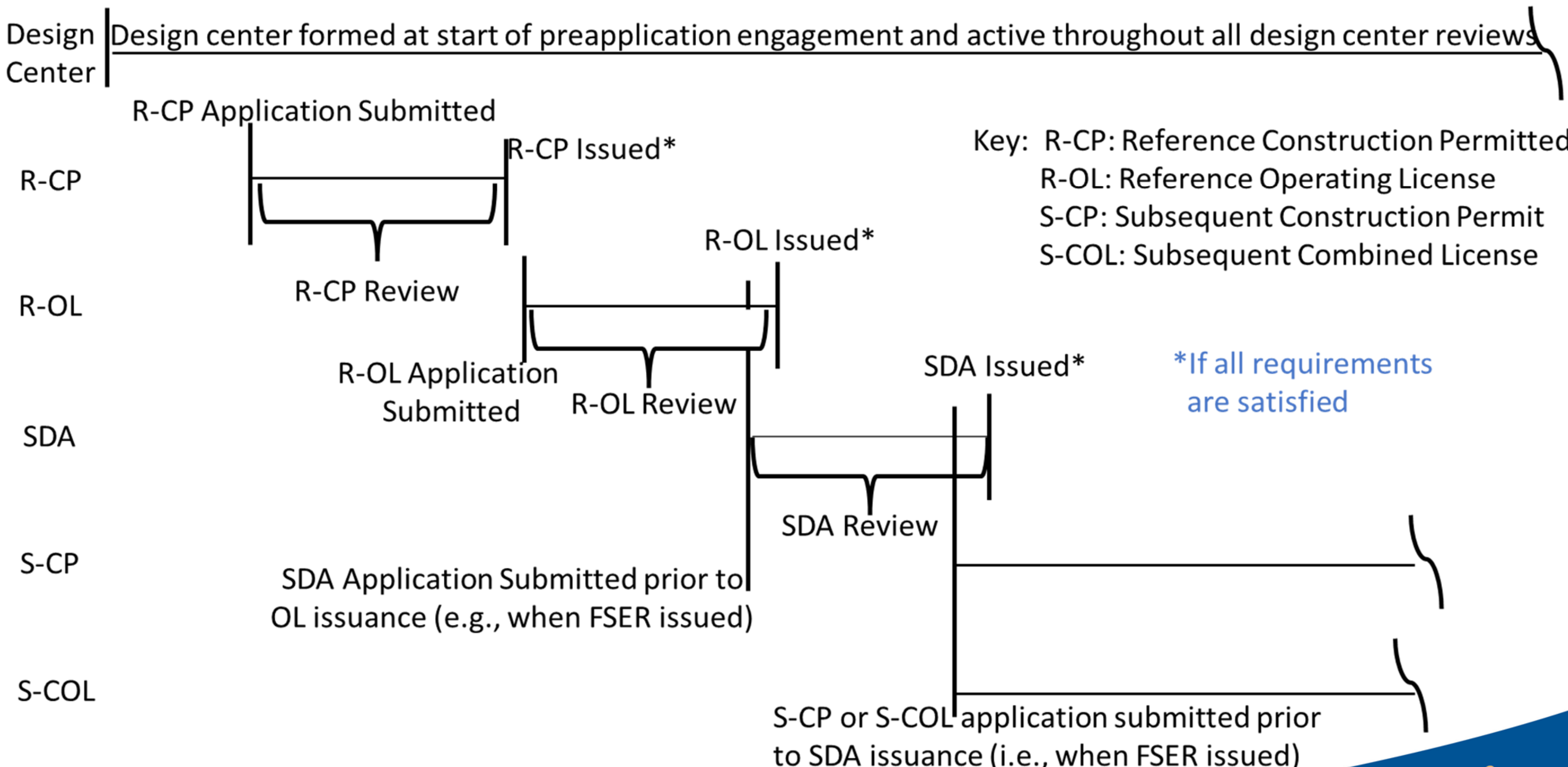
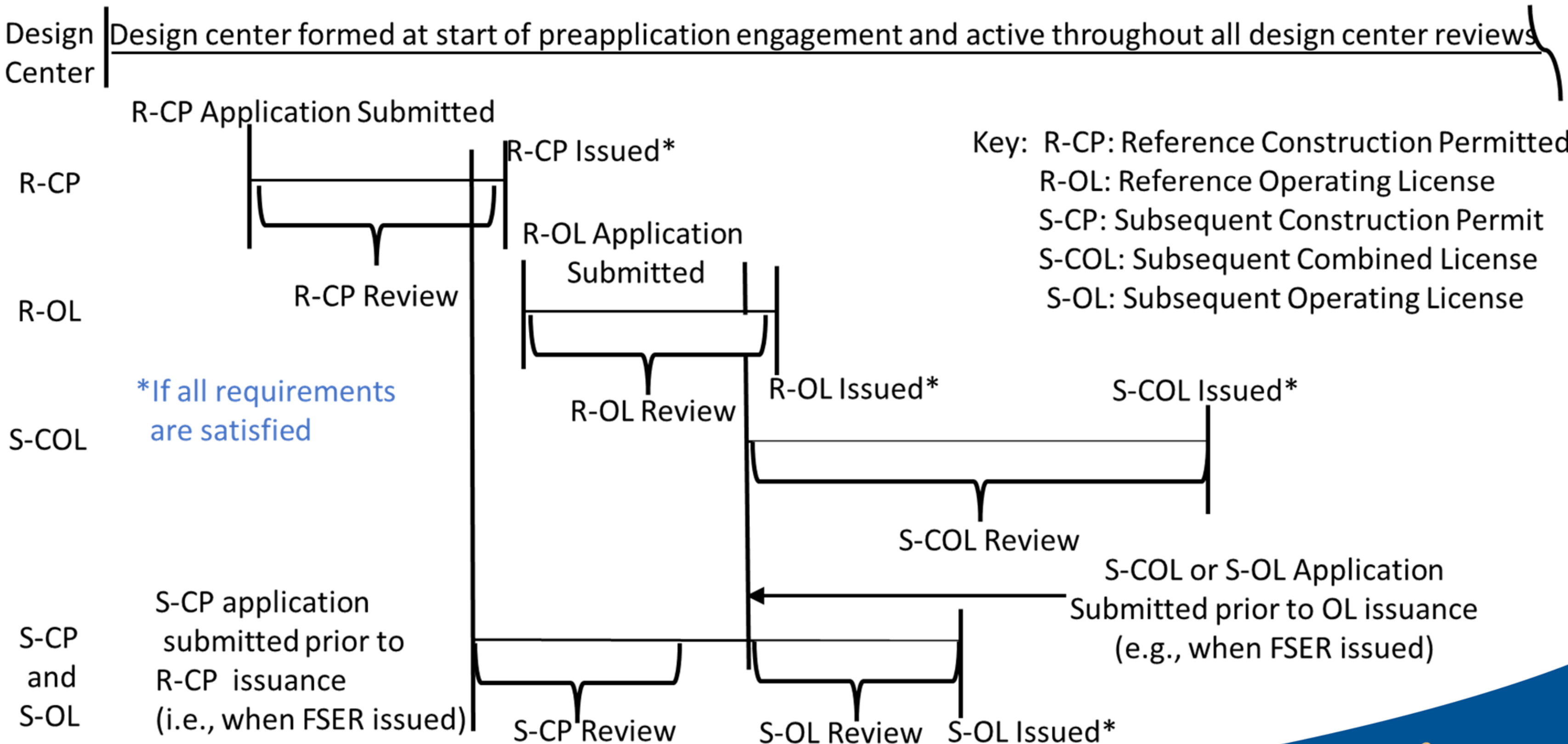


Figure 5: Reference Construction Permit/Operating License to Subsequent CP, COL, and OL

R-OL Schedule Overlaps with Preapplication Engagement, S-CP, S-COL and S-OL Schedules



Conclusion

- FSAR version available at the time the OL for the facility is issued contains a set of standard information on the design that can be used in the development of a standard design approval application

- Identification of standard information and its migration to a standard design approval application should be focused on the scope of the standard design and migrating the exact language from the version of the OL FSAR, to the extent practicable

- Engaged design center has the potential to facilitate a more effective, efficient, and timely review benefiting all applicants and the NRC by improving regulatory consistency and minimizing the resources needed to conduct both the standard design approval and subsequent reviews referencing it

Moving forward

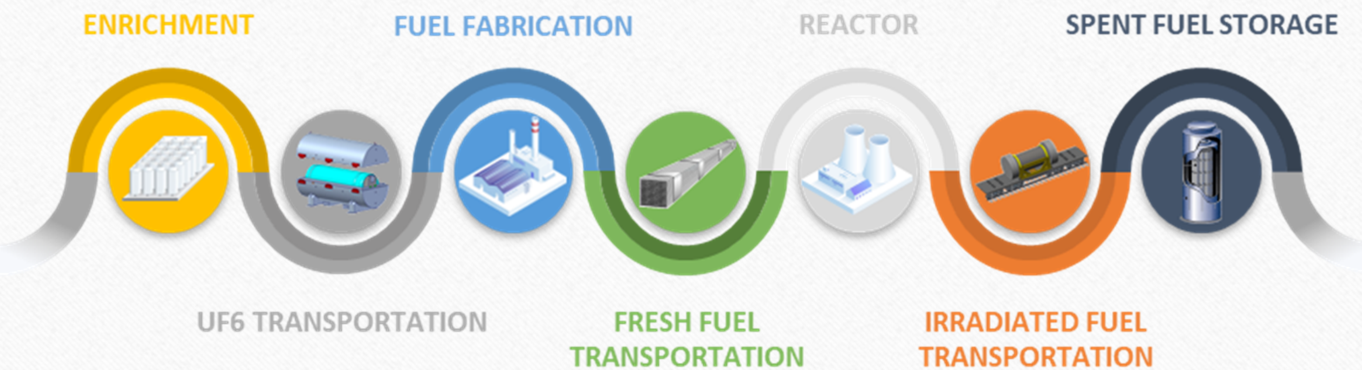
Items the staff is still looking at include:

- Finality of operational programs in a standard design approval
- Use of Appendix N
- Stakeholder Feedback
- Update current guidance, or issue a related generic communication, based on the white paper
- Request public comments

Updates from the Office of Nuclear Material Safety and Safeguards (NMSS)

NEW FUELS

- Front-end of the Fuel Cycle
- Back-end of the Fuel Cycle



10 min BREAK

Future Focused Research: Integration of Safety, Security, & Safeguards During Design and Operations

Advanced Reactors Stakeholder Meeting

October 25, 2023

Safety-Security-Safeguards FFR

- Project will use case studies to explore the interfaces between the 3 Ss during design and operations
- Identify modeling and simulation tools and approaches that may be used to address these interfaces
- Identify potential synergies and conflicts among the interfaces

Objectives:

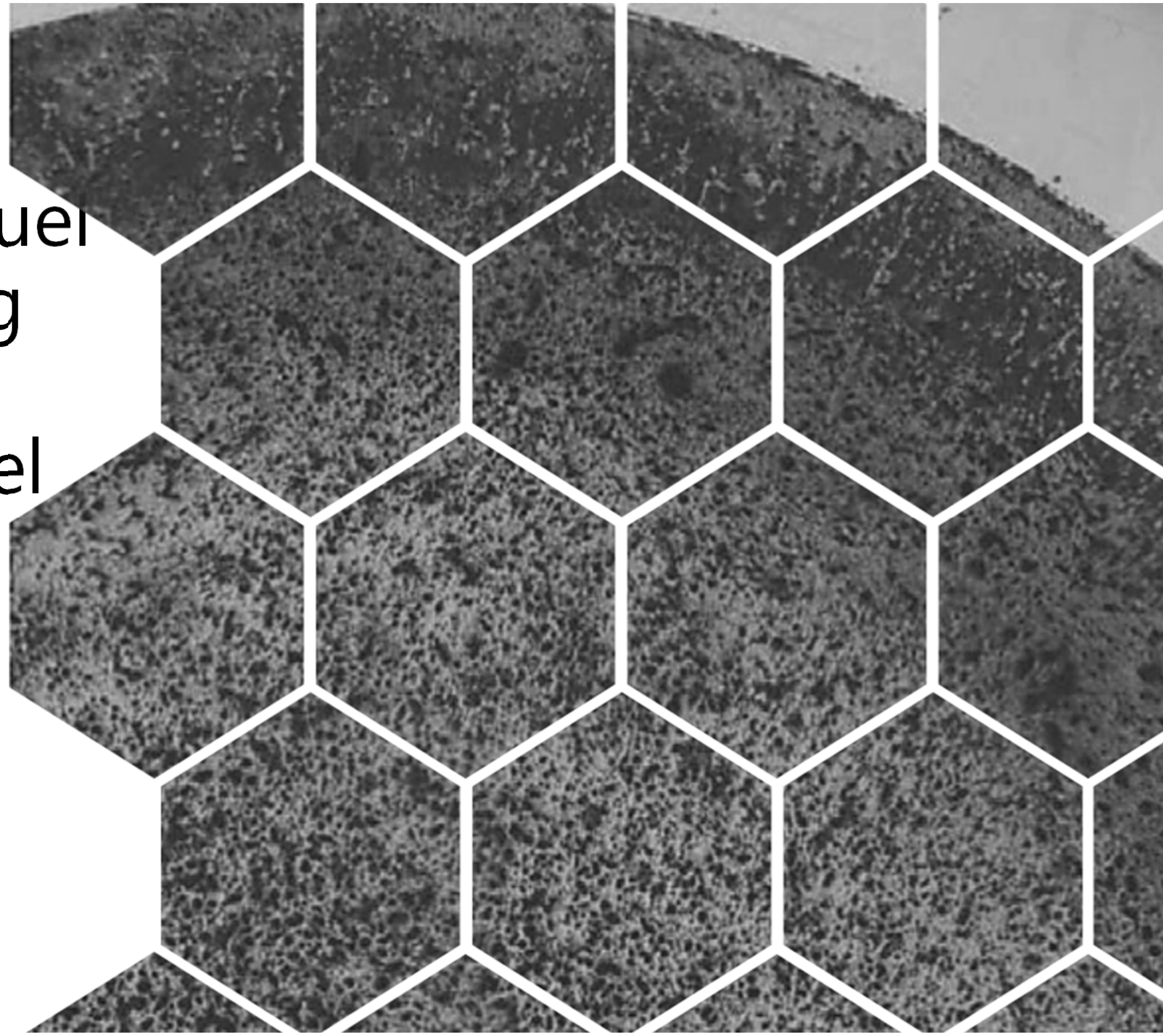
- Facilitate exchange of knowledge and best practices for design and operations of advanced reactors and fuel cycle facilities using an integrated safety, security, and safeguards (3S) approach.
- Foster information exchange of research and development activities and potential applications of 3S.
- Identify 3S M&S tools and applications.

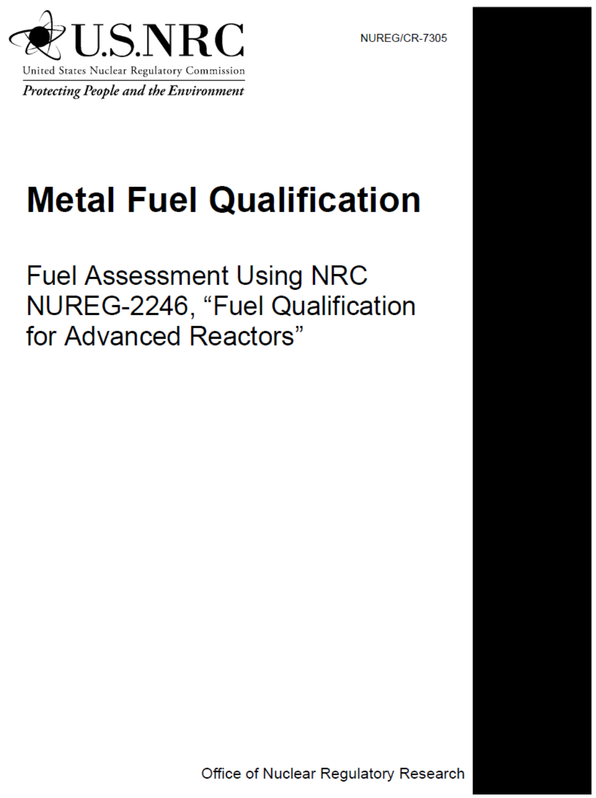
**December 5 and 6, 2023
(Virtual)**

NUREG/CR-7305, Fuel Assessment Using NRC NUREG-2246, “Fuel Qualification for Advanced Reactors”

James Corson

Walter Williams





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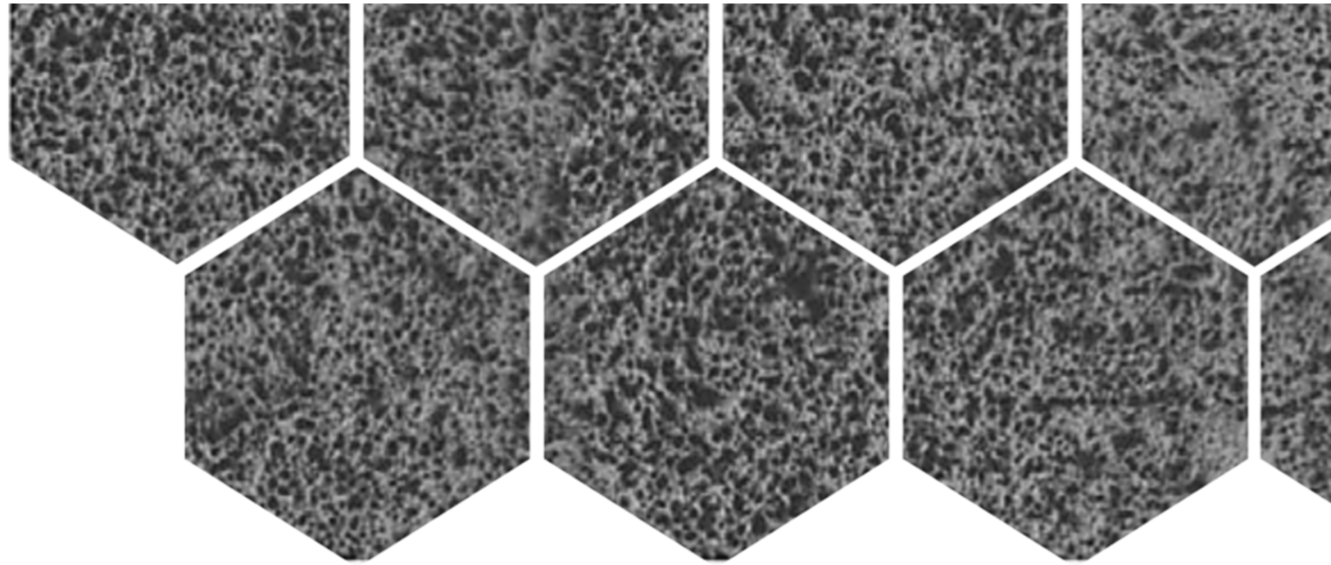
NUREG/CR-7305

Metal Fuel Qualification

Fuel Assessment Using NRC NUREG-2246, “Fuel Qualification for Advanced Reactors”

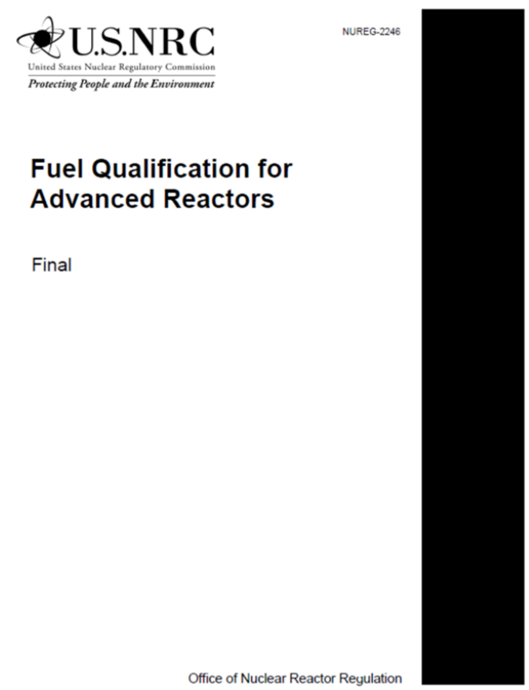
Office of Nuclear Regulatory Research



- Motivation: apply NUREG-2246, Fuel Qualification for Advanced Reactors, to U-Pu-Zr/U-Zr fuel
  - Work performed by INL
  - Similar work at PNNL and ORNL for TRISO and molten salt fuel
- Primary supporting data originated from EBR-II and FFTF

NUREG-2246: Fuel Qualification for Advanced Reactors

- Identifies criteria to support fuel qualification
- Addresses accelerated fuel qualification
- Emphasizes
  - Identification of key manufacturing parameters
  - Specification of fuel performance envelope
  - Use of evaluation models
  - Assessment of experimental data used to validate models and to develop safety criteria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NUREG-2246

Fuel Qualification for Advanced Reactors

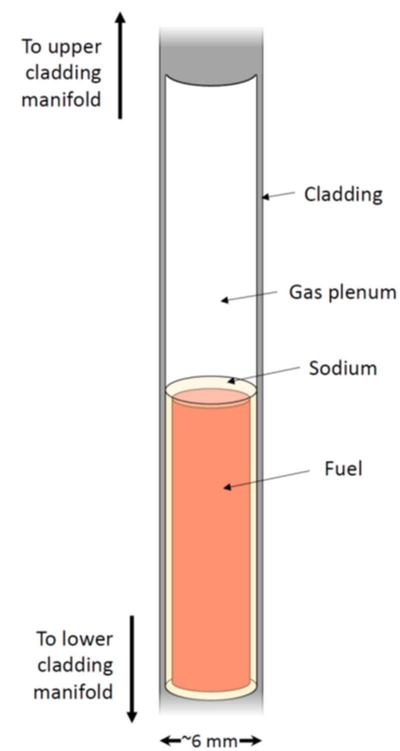
Final

Office of Nuclear Reactor Regulation

Design Parameters

Parameter	Value
Nominal fuel composition	U-10Zr
Fuel theoretical density	16.2 g/cm3
Fuel slug smeared density	75%
Plenum-to-fuel volume ratio	1.4
Fuel height	91 cm
Fuel outer diameter	0.5 cm
Cladding outer diameter	0.69 cm
Cladding inner diameter	0.57 cm
Fuel-cladding bond	Na
Cladding material	HT9

EBR-II Fuel rod



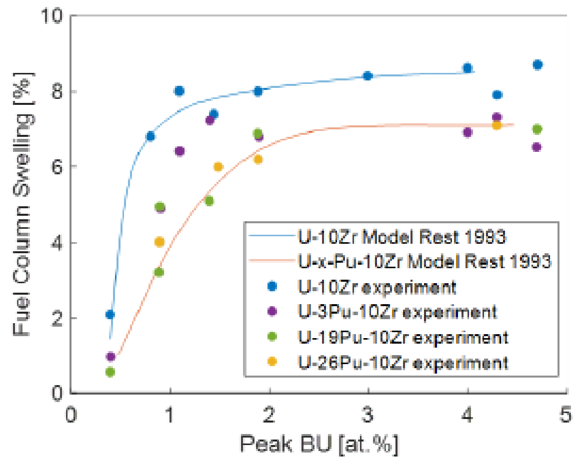
Areas of Focus

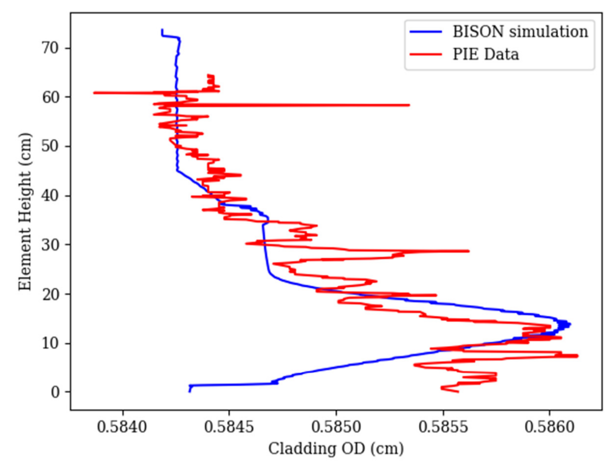
- Geometric Evolution
- Fuel Constituent Migration
- Fuel Properties
- Cladding Integrity/Barrier Degradation
- Fission Product Behavior/Source Term
- Transients

- These points were identified as the main factors for defining an operating envelope and developing an assessment criteria
- Investigated through experimentation and modeling

- **Geometric Evolution**
- Fuel Constituent Migration
- Fuel Properties
- Cladding Integrity/Degradation

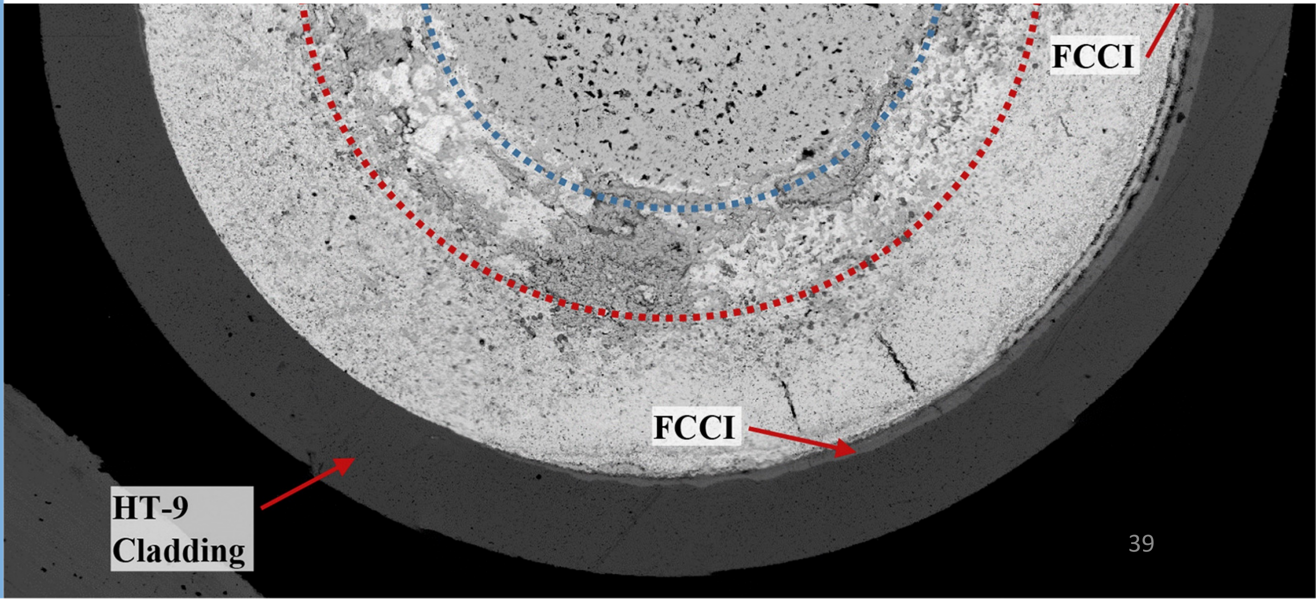
- Fuel column swelling does affect reactivity, but is well known and stabilizes
- Radial strain largely accommodated for by smear density and thought to be predictable
- Large database of experiments available. Additional work needed to illustrate model/experiment agreement or illustrate trends in the experiment data.





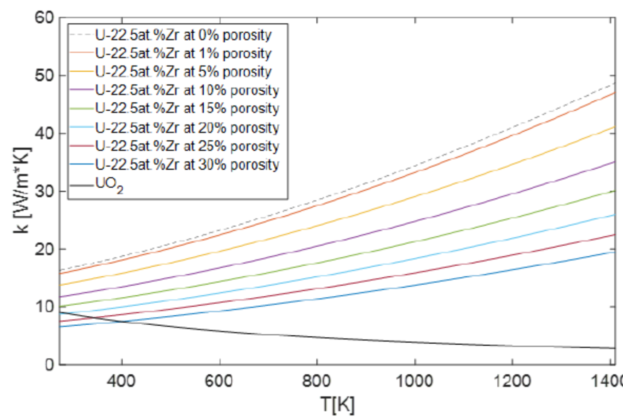
- Geometric Evolution
- **Fuel Constituent Migration**
- Fuel Properties
- Cladding Integrity/Barrier Degradation

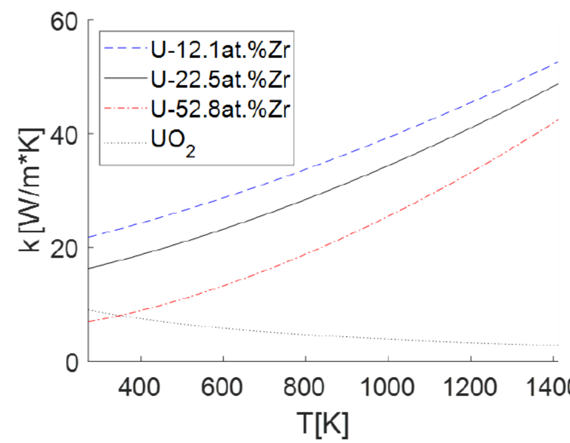
- Redistribution is not shown to limit fuel performance.
- It will affect thermal conductivity and fuel swelling, but mechanistic understanding, while available, is not yet needed for a safety case
- FCCI is propagated by the redistribution and is the limiting fuel performance phenomena



- Fuel Constituent Migration
- **Fuel Properties**
- Cladding Integrity/Barrier Degradation
- Fission Product Behavior/Source Term

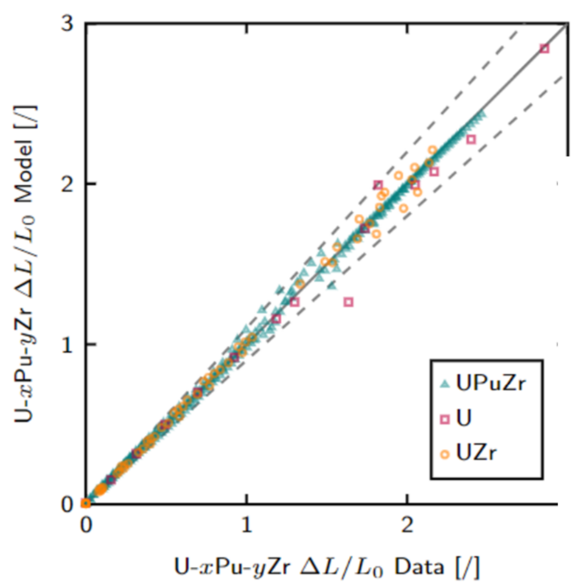
- Porosity and redistribution will affect thermal conductivity (TC), yield strength, and solidus temperature
- TC remains favorable, even without known Na infiltration
- Yield strength favors fission gas release to plenum and dimensional stability with proper smear density
- Solidus temperature limited by FCCI rather than bulk constituents

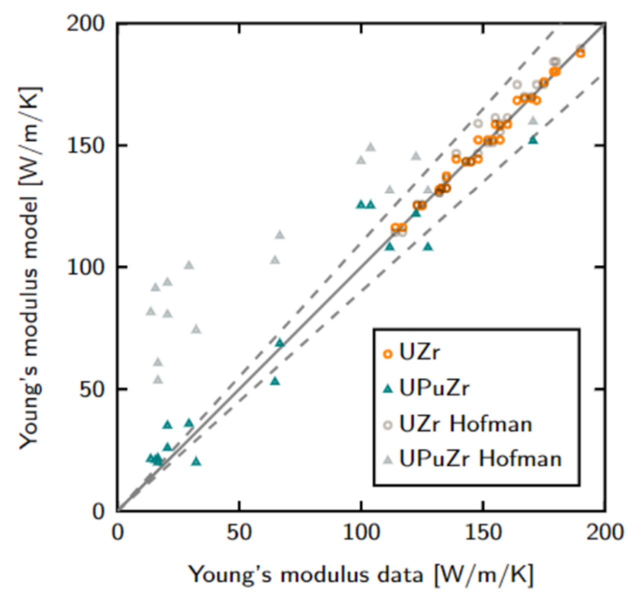




- Fuel Constituent Migration
- **Fuel Properties**
- Cladding Integrity/Barrier Degradation
- Fission Product Behavior/Source Term

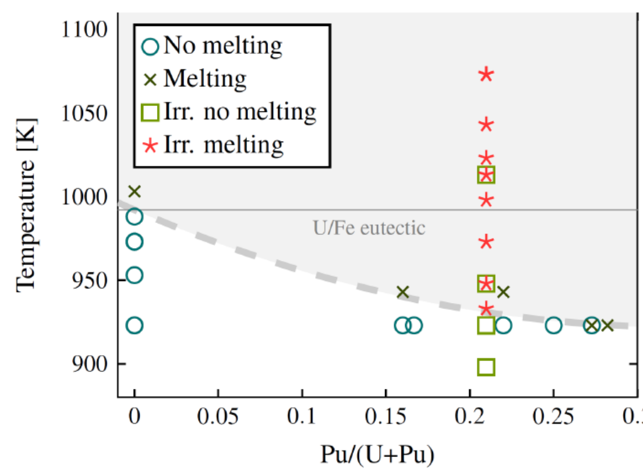
- Thermal expansion and Young's modulus are well known and predictable
- (Further bolsters geometric stability case)





- Fuel Properties
- **Cladding Integrity/Barrier Degradation**
- Fission Product Behavior/Source Term
- Transients

- Swelling is not a concern in HT-9 clad U-Zr fuel with 75% smear density up to 10at.% BU.
- FCCI is the primary source for cladding degradation and pin failure
- FCCI may thin the cladding and lower eutectic melting temperature.
- While not a concern for steady state below 10at.% BU, the response and behavior under transients requires more investigation

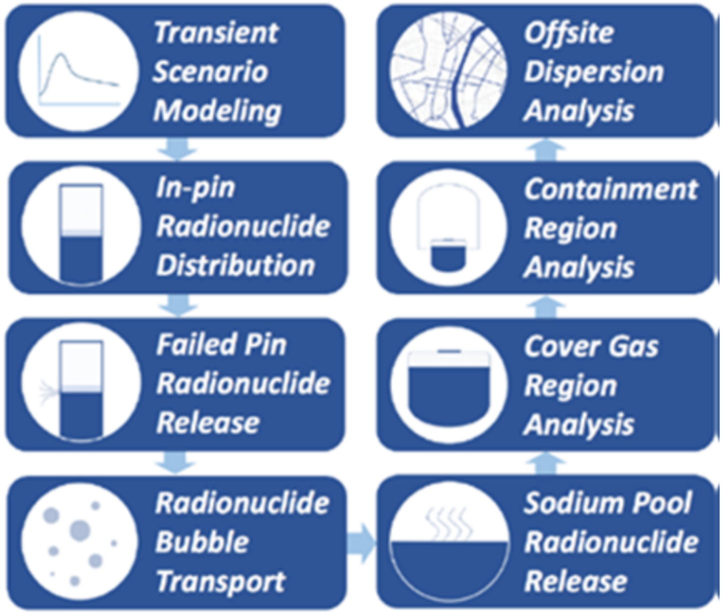


Degradation

- **Fission Product Behavior/Source Term**

- Transients

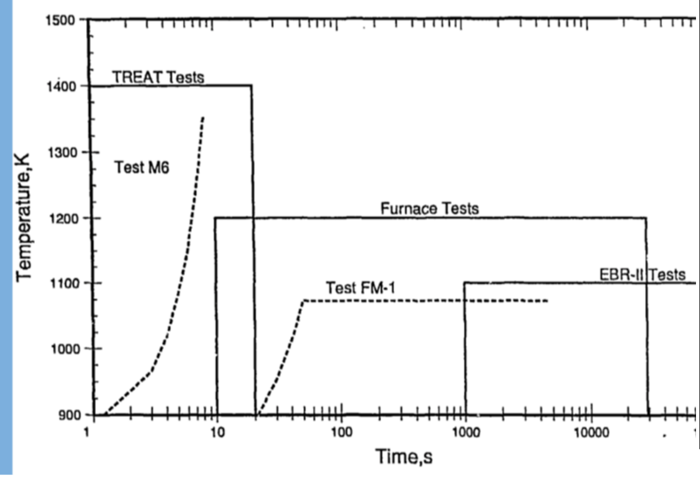
- As source term and fission product retention/release is highly subjective to conditions, there is an inherent difficulty to summarize.
- However, source term and inventory are well known and calculated for steady state. Transient response remains and area requiring additional research



- Fission Product Behavior/Source Term

- **Transients**

- Transient testing has been done and identified FCCI to be the primary failure mode
- Fuel has been shown to survive a 0.1%/s overpower transient to ~40% overpower without cladding breach
- There remains a need for additional testing to better illustrate the extent that FCCI degrades the barrier and how that barrier responds to said conditions and develop an improved operation envelope.



Experiment	Fuel/Cladding	Fuel Design (EBR-II)	BU, at%	Test Overpower, *Indicates Cladding Failure	Calculated Breech Threshold Overpower (Normalized)	Maximum Fuel Axial Expansion, %	Maximum Pin Pressure, MPa
M2	U-5Fs/316SS	Mark-II	0.3	4.1	4.7	16	0.6–0.8
M2	U-5Fs/316SS	Mark-II	4.4	4.2*	4.5	—	7–9
M2	U-5Fs/316SS	Mark-II	7.9	4.1*	3.6–4.0	3	17–20
M3	U-5Fs/316SS	Mark-II	0.3	4.1	4.8	18	0.6–0.8
M3	U-5Fs/316SS	Mark-II	4.4	4.0	4.4	4	7–9
M3	U-5Fs/316SS	Mark-II	7.9	3.4	3.6–4.0	4	17–23
M4	U-5Fs/316SS	Mark-II	0.0	3.8	4.3	4	7–9
M4	U-5Fs/316SS	Mark-II	2.4	4.1*	4.4	7	2–6
M4	U-5Fs/316SS	Mark-II	4.4	3.8	4.3	4	7–9
M5	U-19Pu-10Zr/D9	X419, X420, X421	0.8	4.3(3.4)	5.1(4.6)	1(1)	1(1)
M5	U-19Pu-10Zr/D9	X419, X420, X421	1.9	4.3(3.4)	5.1(4.6)	2(0.5)	3(3)
M6	U-19Pu-10Zr/D9	X419, X420, X421	1.9	4.4	4.6	2–3	3
M6	U-19Pu-10Zr/D9	X419, X420, X421	5.3	4.4*	4.5	3	10
M7	U-19Pu-10Zr/D9	X419, X420, X421	9.8	4.0*	4.4	3	19
M7	U-10Zr/HT9	X425	2.9	4.8	4.4	2–4	6

Bulk Findings

- Geometric stability: well known and favorable below 10at% BU.
  - Intrinsic loss of power and heat generation due to swelling
  - Known and accommodated for with smear density
- Coolability: fuel retains favorable thermal conductivity throughout all cases
- Transient response: area needing more research or representation
  - While FCCI is known to be the limiting factor, the barrier response and fission product retention under transients is not well described at this time.
- Operation envelope (steady state and transient, e.g., time at temperature allowances) should be better illustrated
- Final finding was fuel design and geometry must be decided upon for a final fuel qualification case.
- Successful test of NUREG-2246 with no changes in the document requested

LUNCH

Enhancing International Regulatory Efficiency

NRC Advanced Reactor Stakeholder Meeting

October 25, 2023

Marc Nichol
Executive Director, New Nuclear

NUCLEAR ENERGY INSTITUTE

Advanced Reactor Enablers and Opportunities

01 First Mover Success	1. Government policies are equitable for nuclear and fully funded 2. Policies support industry's implementation of project best practices 3. Building education and comfort in the investment community
02 Fast Followers	4. Decisions that support industry's achieving de-risking milestones 5. Actions that support industry's pursuit of standardization of fleets
03 Regulatory Efficiency	6. Regulatory reform and modernization 7. Congress and Parliament to enable regulatory reform
04 Siting Availability	8. Rapid decision making to enable designs that are capable of being deployed in a wide range of site conditions 9. Industry will need to develop flexible designs that are both standardized and adaptable
05 Public Engagement	10. Governments enable early engagement of public in processes 11. Enable communities to more effectively engage the industry on advanced reactors 12. Collaborative engagement of Indigenous peoples
06 Supply Chain Ramp-up	13. Congress and DOE establish programs to assure access to fuel 14. Government support for prototyping novel components early in design
07 Workforce Development	15. Government programs support industry's action to establishes programs to recruit, train and retain workers

Source: Advanced Reactor Roadmap, https://publicdownload.epri.com/PublicAttachmentDownload.svc/AttachmentId=83812

Two Recent Reports – September 2023

- "*A Framework for International Regulatory Efficiency to Accelerate Nuclear Deployment*," World Nuclear Association, Canadian Nuclear Association and Nuclear Energy Institute

- "*Canadian and United States Regulatory Cooperation for New Nuclear Deployment: Recommendations for the Implementation of the International Regulatory Efficiency Framework,*" Canadian Nuclear Association and Nuclear Energy Institute

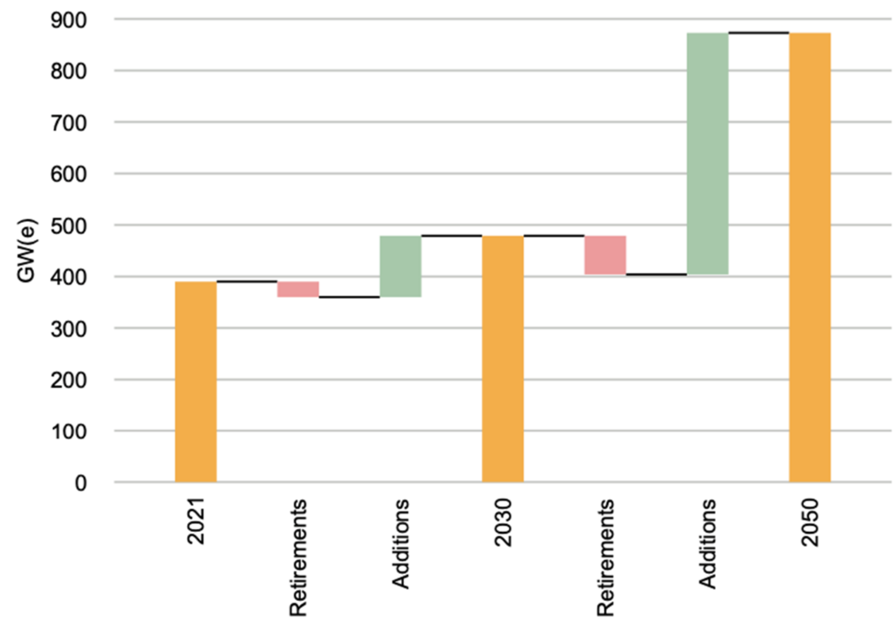
A Framework for International Regulatory Efficiency to Accelerate Nuclear Deployment

The Need for Nuclear Now

- Increasing urgency for carbon reduction (electric and non-electric)
- Path to zero-carbon must be reliable and affordable
- Nuclear energy must be meaningful part of future energy portfolio
- Advanced reactor deployment plans increasing rapidly and more urgently
- Up to 40 GWe of new nuclear added every year for the next 25 years (6x recent experience)

FIGURE 7. WORLD NUCLEAR CAPACITY: ACTUAL, RETIREMENTS AND ADDITIONS

HIGH CASE



Source: IAEA "Energy, Electricity and Nuclear Power Estimates for the Period up to 2050," September 2022
Note: Other sources estimate a need of up to 1,250 GWe by 2050 (WNA and IPCC), these estimates do not include non-electric applications

The Need for a New Approach

Regulatory efficiency is needed so that society can enable safe advanced reactors to provide benefits that meet energy, climate, environmental, economic and security goals

- License applications could be more than regulators can currently process
- Unnecessary duplication of effort in regulatory reviews for localization of previously approved designs
- Unnecessarily long times and high costs to license safe designs
  - Limit regulatory throughput
  - Inhibit ability to license in many countries

U.S. Licensing Durations and Costs

Type[1]	Duration[2]	Cost[3]
DC	3 to 4 years (4 to 9)	\$45M to \$68M
COL	2.5 to 3.5 years (4)	\$28M to \$30M
ESP	2 years (3 to 6)	\$6M to \$19M
OL	3 to 3.5 years (8)	\$42M

1) DC = Design Certification, COL = Combined Operating License, ESP = Early Site Permit, OL = Operating License
2) NRC Generic Schedules: https://www.nrc.gov/about-nrc/generic-schedules.html; "()" reflects historical performance which has exceeded generic schedules, in some cases by more than double; these generic and historical schedules do not include pre-application, acceptance, commission approval and hearings/rulemakings which adds 1 to 3 years to the actual schedule
3) NRC Letter to Senator Inhofe April 7, 2015 (ML1508A361), costs of more recent reviews are even higher on an inflation adjusted basis

Challenges Driving Need for International Regulatory Efficiency

- Costs (Regulatory Fees and Vendor Support) for reviews that do not leverage approval in another country

  => $1B to approve in 4 countries

- Duplicating reviews of the same design
  - Capital required constrains deployment to other countries
  - Regulatory resources slows market adoption
- Differences (real or perceived) in regulatory approaches
  - Influence design changes specific to each country
  - Reduce ability of operators to share experience

Vision for International Regulatory Efficiency

- Licensing of nuclear reactors measurably more efficiently than in the past
  - Continue to ensure nuclear safety, security and safeguards
  - Minimize time and cost for approving a design already approved by another regulator
  - Experienced regulators support embarking regulators
  - One regulator leveraging all or part of the outputs from another regulator
  - Regulators collaborating to review different aspects, incorporating outputs from each other
  - Accepting design reviews by other regulators without repeating full review
  - Policy and mechanisms to enable multilateral regulatory reviews
  - Regulators' expectations (requirements and inputs/outputs) are clear for industry and other stakeholders
  - Synergies among countries' regulatory frameworks promote design standardization
  - Industry is able to utilize large parts of the same supply chain across countries

Experience in Nuclear Regulatory Harmonization

- Multinational Design Evaluation Programme (MDEP)
- Western European Nuclear Regulators Association (WENRA)
- International Regulators Association (INRA)
- IAEA Nuclear Harmonization and Standardization Initiative (NHSI)
- European SMR Pre-Partnership
- Joint European early review of NUWARD
- CNSC and NRC Memorandum of Cooperation (MoC)
- Canadian and Policy regulator SMR Collaboration

International Regulatory Efficiency – Learning from Experience

- International Harmonization is tough
  - Many regulators lead to exponential differences in requirements
  - Resistance to modify requirements to align internationally
  - Risks slowing down regulatory approvals if not managed carefully
- Bi-lateral efforts appear to be easier (US/Canada)[1]
  - 2019 MOC – Shared review approaches, pre-application collaboration, research and training (ML19275D578)
  - NRC/CNSC joint reviews – Terrestrial, X-energy, NuScale and GEH
  - NRC/CNSC harmonization – High Temperature Vessel Code (ML2116A294) and Risk-Informed Licensing (ML21225A101)
  - BWR X-300 – Charter for collaboration

1) https://www.nrc.gov/reactors/new-reactors/advanced/international-cooperation/nrc-cnsc-moc.html

Key Lessons and Successes

- Vision – strategic goals, common objectives, desired outcomes
- Resources – sufficient and dedicated for duration of initiative
- Stakeholders – industry, public, government should be included
- Scope – start small and grow, specific and carefully considered
- Management – mechanism for incorporating outputs into regulatory frameworks
- Outcomes – different regulators can develop common positions, can achieve greater clarity in shorter period of time

However; Maximum Reciprocity should not be forgotten as a long-term aspiration

- Maximum Reciprocity: Approved once, accepted everywhere
  - Provides maximum benefit of international cooperation
  - Has been proven feasible in other industries
- Aviation Example
  - Design: Bi-Lateral Safety Agreement (reciprocal) U.S. has agreement with 50 countries
  - Articles: Reciprocal Acceptance between U.S. FAA, TCCA and EASA
- Pharmaceuticals Example
  - Began in Europe in 1970s, ICH guidelines since 1990 (20 members)
- Nuclear material transport – IAEA Requirements – since 1960s

Regulatory Efficiency Proposed Framework

NEI

Key Activities

Aspiration	**Phase 3 - Full efficiency (Aspiration)** • Joint design review activities • Alignment of requirements / approaches • Embarking nuclear countries functioning as an intelligent customer
Mid-term goals	**Phase 2 - Safety recognition with increased efficiency** • Define approach to acceptance on key safety criteria • Expand the areas on which a common scope of review has been agreed • Agree on safety evaluation on a limited scope of design
Near-term objective	**Phase 1 - Technical cooperation and recognition** • Align existing activities • Understanding of intra-regulator working practises • Identification of the areas on which a common scope of review can be agreed

Increasing collaboration and regulatory efficiency ↑

Desired Outcomes

- Mutual validation and acceptance of regulatory assessments of reactor designs amongst national regulators
- A "Localization Roadmap"
- A "Rosetta Stone" that aligns national regulators on safety objectives, requirements, and expectations
- Identification of the areas on which a common set of requirements can be agreed
- Advanced cooperation and integration with efficiency improvements
- Overall vision and objectives for increased efficiency agreed to by key stakeholders

Figure 1. Three-phase approach to increasing collaboration and regulatory efficiency

Canadian and United States Regulatory Cooperation for New Nuclear Deployment: Recommendations for the Implementation of the International Regulatory Efficiency Framework

Goals for Strategic U.S./Canada Regulatory Cooperation

Enhance confidence in safety through collaboration

Successful large-scale deployment of new nuclear energy is needed to meet the nation's energy, climate, environmental, economic and security goals. Efficient regulatory pathways are needed to achieve this goal.

1) Domestic Preparedness

Potential for international efficiency is dependent on achieving domestic regulatory efficiency

- Goal: Regulate safe nuclear energy as efficiently as possible
- Regulatory objectives[1]
  - Timely and cost-efficient review processes
  - Resolution of key generic technical and policy issues before applications are submitted
  - Changes to regulations for longer-term regulatory framework modernization
- Recommendations:
  - Regulator: Establish more reasonable licensing schedules and costs
  - Regulator: Improving efficiency in the review process
  - Regulator: Apply requirements appropriate to the technology
  - Industry: Articulate how safety enhancements enable efficient regulation
  - Government: Provide sufficient resources to regulators

1) NEI Letter to NRC, Input on Regulatory Priorities, June 7, 2022;

2) Regulatory Cooperation Agreements

Goal: Provide immediate benefits to near-term applicants, while working toward greater long-term efficiencies

Technical Cooperation
- Share technical insights on designs in each country
- Perform joint technical reviews and issue joint documents of their results
- Build confidence in peer's competency (informs Stars 2 and 3)
- Understand similarities and differences in regulatory frameworks (informs Star 3 and 4)

Technical Recognition
- Near-term goals for more advanced cooperation
- Accept peer's validation of designer's design and analytical outputs
- Avoid re-confirmation that design and analysis output is correct

Safety Recognition
- Build on Stars 1 and 2, work towards mid-term goals
- Accept certain peers' validation that a design meets safety limits
- Agreed on safety evaluation on a limited scope of design (e.g., Topical Report) where requirements are the same in both countries

Partial Reciprocity
- Longer-term goals
- A "Rosetta Stone" to translate regulatory approvals from one country to another
- A "Localization Roadmap" which defines the scope of design that needs to reviewed locally to confirm compliance with different requirements

Harmonization
- Aspirational goal
- Alignment of regulatory frameworks (regulations and laws)
- Full reciprocity of approval from the other regulator

Recommendations for NRC/CNSC

- Establish long range plan to enable 4-star and 5-star cooperation
- Expand cooperation through
  - Joint review of additional designs
  - Include other countries in cooperation
- Establish mechanism for greater discussion with industry and other stakeholders on long-term cooperation goals and plans

NRC Cooperation with International Regulators

Consistent with NRC Mission

- In the U.S., the Atomic Energy Act designates the NRC as the U.S. Regulatory Authority
  - Sole authority for making decisions and issuing licenses in U.S. on matters of nuclear safety
- Nothing in the AEA precludes the NRC from relying on information from a regulatory authority in another country for making decisions and issuing licenses
  - The NRC is required to have a reasonable assurance of adequate protection of the public health and safety – thus there would need to be reasonable assurance in the information from another regulator that serves as the basis for the safety finding
  - Analogies with NRC current practice of relying on technical work from contractors
- There are examples of this in the nuclear field, for example in transport of nuclear materials (NRC Part 71 and IAEA SSR-6)
- Other types of regulators are able to collaborate and rely on decisions from regulatory authorities in other countries: Example: FAA and FDA

3) Assistance to Potential Host Countries

- The goal of Canadian and U.S. assistance to potential host countries is to accelerate the safe deployment of nuclear energy in host countries.
  - Significantly improve the global achievement of carbon reduction and energy security goals.
  - Spread high standards for nuclear safety, security and non-proliferation
  - Increase diplomatic ties and create economic benefits in the supplier and host countries
- Recommendations
  - NRC/CNSC: Expand international regulatory cooperation and assistance to regulators in potential host countries to maximum extent possible
    - Prioritize countries with near-term deployment of U.S./Canada designs
    - Ensure appropriate support for countries seeking to build regulatory capacity
    - Transfer expertise and experience in regulatory framework for advanced reactors
  - Governments: Establish relationships with potential host countries
    - Inform them of the regulatory cooperation and assistance that is available
    - Understand the host countries regulatory assistance needs
    - Facilitate US/Canadian support for development of nuclear energy and adoption of advanced reactor technologies

4) Codes and Standards

Alignment of international codes and standards enables greater regulatory efficiency

- *The goal of codes and standards alignment is to minimize the differences between codes and standards endorsed by cooperating regulators.*
- Minimization of differences between C&S accepted by international regulators
  - Reciprocity in acceptance of other country's codes and standards
  - Joint development of C&S between countries (e.g., ANS and CSA)
  - Utilization of international standards (e.g., ISO-9001)
- Recommendations
  - SDO's: Establish a forum for standards development organizations (SDOs), industry and regulators
    - Centered around US/Canada; includes other countries (e.g., Europe, Asia)
    - Identify gaps, establish priorities and plans for developing codes and standards (C&S)
    - Already underway, led by ASME, CSA and ANS
  - Regulators: Engage with cooperating regulators, industry, SDOs to endorse aligned C&S
  - Developers: Engage with SDOs and regulators to identify priorities and approaches that maximize alignment of C&S

5) Design Standardization

- *The goal of design standardization is establishment of a stable design, for the portion of the plant that requires regulatory approval, that benefits from requirements that are streamlined between two or more regulators to the extent practicable.*
  - No, or minimal, design changes from one country to another
  - Compliant with requirements in all countries of anticipated deployment
  - Compliant with relevant codes and standards in all countries of anticipated deployment
- Enablers of design standardization
  - Clarifying the alignment of requirements and expectations (among collaborating regulators) early in the design
  - Crediting the equivalent outcomes of requirements between regulators to avoid the need for a summation of the most conservative version of the requirements
  - Only requiring scope and detail of design for review that is necessary for safety decisions
- Recommendations
  - Regulators: Guidance on similarities and differences between regulatory requirements of cooperating regulators
  - Developers: Design with safety profiles that enable the portion of the design reviewed by regulators
    - Stable with no anticipated changes for site conditions or technology advancements
    - Aligned with requirements across cooperating countries

Summary Recommendations

1. NRC/CNSC with industry, SDOs and other stakeholders: continue discussions on the pursuit of the 5 long-term goals and 13 near-term actions
2. U.S. and Canadian Governments: provide resources to expand international regulatory efficiency
3. Inform international efforts for advanced reactors (e.g., IAEA NHSI)

DISCUSSION

By Third Way, GENSLER

Executive Strategic Advisory Council (ESAC)

- ESAC provides stakeholder recommendations to BPV III Standards Committee and its Executive Committee regarding the strategic direction and development across all divisions of Section III
  - Provides input on overall BPV III direction, focus, and priorities
  - Conduit between the Standards Committee and stakeholder senior management
  - Information on key nuclear facility construction issues
  - Conducts periodic meetings with BPV III leadership (every 9 to 12 months)

- Membership
  - Currently about 25 members
  - N Certificate Holders
  - Advanced Reactor Vendors
  - Organizations (EPRI & NEI)

- ESAC is *always interested* in new members
  - Feel fee to discuss membership with us
  - Interested in International Participation

Future Meeting Planning

- The next periodic stakeholder meetings are scheduled for December 7, 2023, and January 24, 2024.

- Potential topics for our next meeting include Selection of a Seismic Scenario for an EPZ Boundary Determination, and Final Rule on Emergency Preparedness for Small Modular Reactors and Other New Technologies.

- If you have suggested topics, please reach out to Ramachandran Subbaratnam at Ramachandran.Subbaratnam@nrc.gov.

How Did We Do?

- Click link to NRC public meeting information:

  https://www.nrc.gov/pmns/mtg?do=details&Code=20230810

- Then, click link to NRC public feedback form:

Meeting Feedback

Meeting Feedback Form EXIT

Meeting Dates and Times