



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

May 3, 2018

Telephone Bridge

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Opportunities for public comments and questions at designated times

# Outline

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- Introductions
- Insights from NuScale Power
- Standards Workshop
- DOE Update
- Guidance for MSR Research/Test Reactors
  
- Safety Focused Review of I&C
- Licensing Modernization Project Guidance
  - Other Needed Guidance ?
- Regulatory Engagement Plans
- Siting Issues
- Policy Issues, Future Meetings, Public Discussion

# Insights from NuScale Power

[NuScale Slides](#)

# Standards Workshop

# DOE Update

[DOE SLIDES](#)

# Guidance for Molten Salt Reactor Research and Test Reactors

[ORNL SLIDES](#)

# Safety Focused Review Instrumentation and Control

[I&C SLIDES](#)



# Licensing Modernization Project Guidance Document

Technology Inclusive  
Risk Informed  
Performance Based

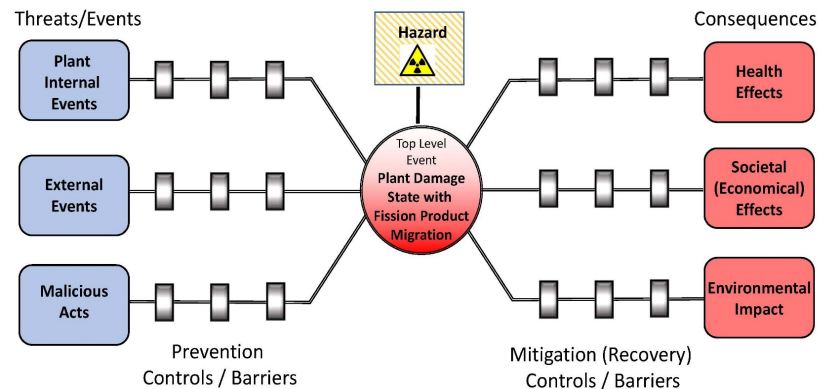
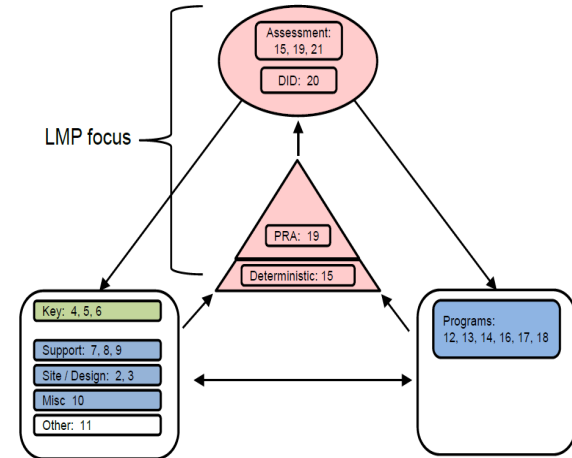
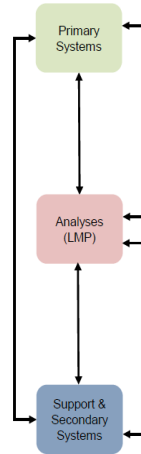
[ML18120A321](#)

# Other Needed Guidance Documents ?

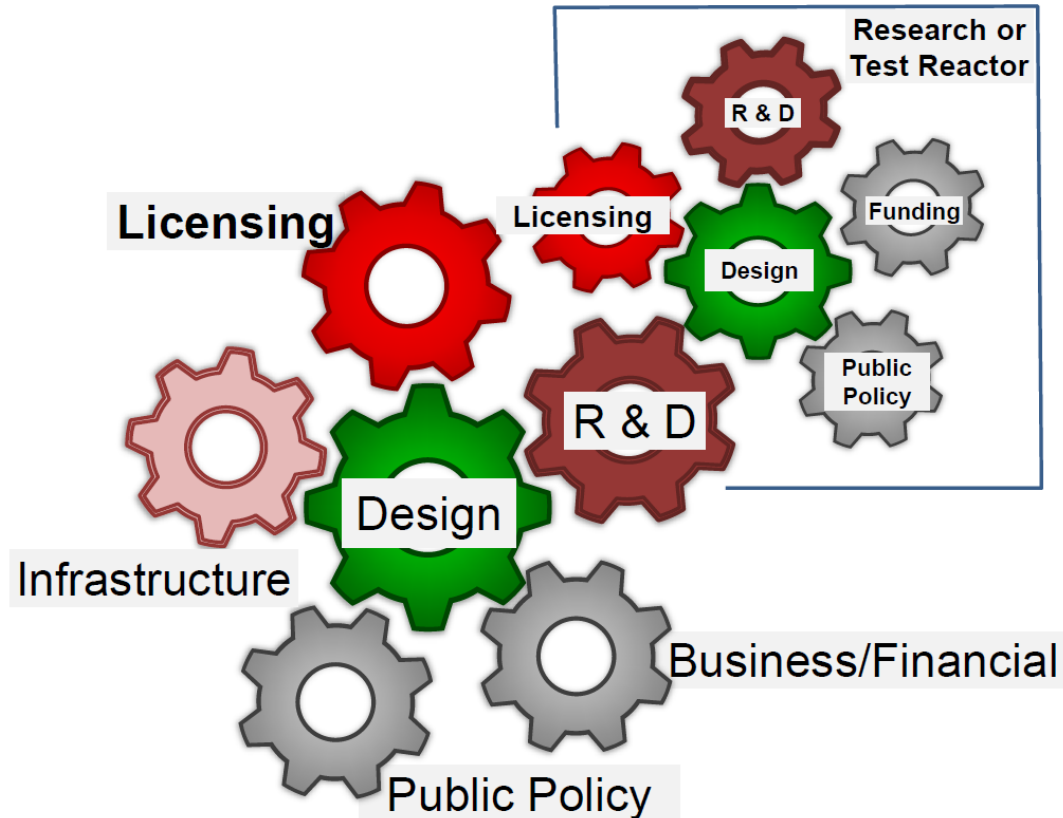
# Scope and Level of Detail

## Integrated Approach

- General Description of the Plant
- Site Characteristics
- Design of SSCs and Equipment
- Reactor
- Reactor Coolant and Connecting Systems
- Engineered Safety Features
- Instrumentation and Controls
- Electric Power
- Auxiliary Systems
- Steam and Power Conversion System
- Radioactive Waste Management
- Radiation Protection
- Conduct of Operations
- Verification Programs
- Transient and Accident Analyses
- Technical Specifications
- Quality Assurance and Reliability Assurance
- Human Factors Engineering
- Probabilistic Risk Assessment/Severe Accident Evaluation
- Defense in Depth
- Emergency Planning
- Security
- Staffing
- Fire Protection
- Mitigating Strategies
- Aircraft Impact Assessment
- Environmental Report
- Financial
- Inspections, Tests, Analyses, and Acceptance Criteria
- Insurance
- Other (design or technology specific)



# Regulatory Engagement Plans



# Siting Issues

[NEI SITING SLIDES](#)

## Policy Table, Future Meetings & Public Discussion

Comments on Stakeholder Meetings from  
Michael Keller, Hybrid Power Technologies

- Untimely Announcement of Meetings
- Public Participation Not Welcome
- Request for Presentation to be Placed In Public Record
  - [ML18122A250](#)

# Policy Table

Previous Version  
ADAMS Acc. No. ML18010A484

[Updated Version](#)  
[Work in Progress](#)

# Future Stakeholder Meetings Topics ?

June 4-5	Public Meeting - Licensing Modernization
June 14	<i>Emergency Planning Zones</i>
	<i>Fuel Cycle / Transportation</i>
	<i>Environmental Reviews</i>
July 26	
Sept 13	
Oct 25	
Dec 13	



# ACRS Schedule (tentative)

Date	Committee	Topic
June 19	Sub	RIPB Guidance
Aug 22	Sub	EP Rulemaking
Oct	Full	EP Rulemaking
Oct 30	Sub	RIPB Guidance

# Public Comments / Questions



# Design Certification Status and NRC Licensing Insights

**Steven M. Mirsky, PE**  
Manager, Regulatory Affairs

**May 3, 2018**



# Acknowledgement & Disclaimer

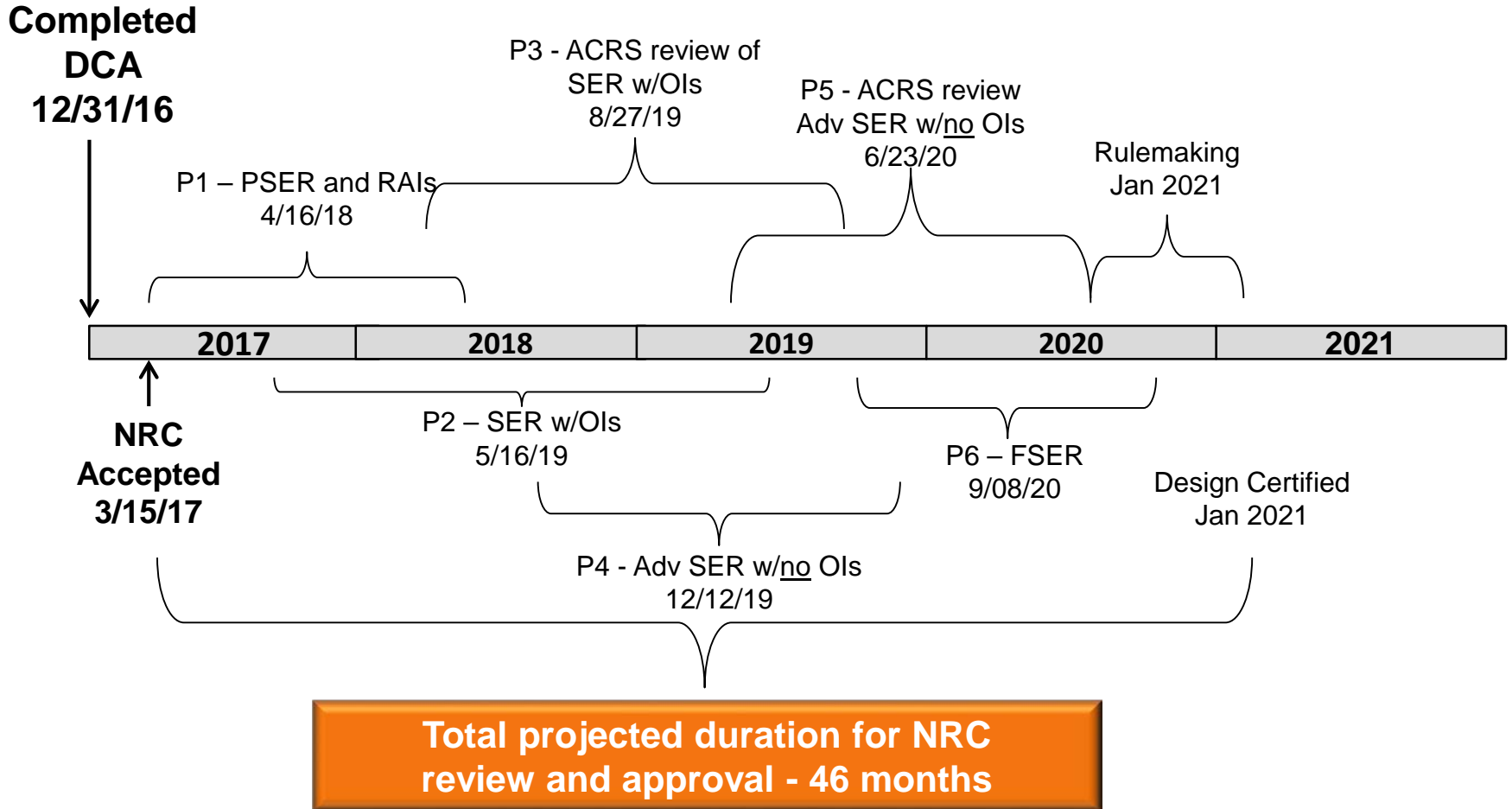
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# DCA Review At-A-Glance

- Review Progressing Well
  - Phase 1 was completed on schedule April 16
  - Phase 3 ACRS meetings beginning
    - Chapter 7 and 8 first to Phase 3 (Summer 2018)
    - Expect to see SER with open items month or so before meeting
    - Informed that Chapter 7 has no open items
  - Fewer questions than prior DCAs
    - Expect <1,500 RAIs
    - >1,000 RAI responses submitted
  - 28 of 35 audits completed
  - 5 of 14 DCA-related topical reports (LTRs) approved
  - Total cost of review at high end of forecast
    - >115,000 NRC review hours
- Improved management by NRC of review
  - Management plans for “key issues”
  - RAI review metrics

# NuScale Baseline DC Review



# Key Accomplishments Since Docketing

- Highly integrated protection system (HIPS) LTR approved in May 2017
- “Non-1E” LTR approved Dec 2017
- Applicability of AREVA fuel methods LTR approved Nov 2017
- DCA Revision 1 Submitted March 15
  - Revised all 10 parts of the DCA
  - Incorporated 973 change packages
- EPZ Methodology LTR Rev 1 Submitted March 12
  - Added method for determining defense-in-depth
  - Addressed all known NRC staff issues

# Key Accomplishments (Cont'd)

- Achieved alignment with NRC on Failed Fuel Fraction
  - 0.066% for normal and accident conditions (compared to typical 0.25/1.0%)
  - Based on latest EPRI PWR fuel performance data
  - Benefits include normal operations shielding calculations
  - Retaining, for now, current SAR Chapter 15 assumption of 0.32% as operating margin
- Proposal to define “credible” in terms of regulations
  - Simplifies approach across a number of regulations
  - NRC appears open to proposal, though likely Policy Issue
  - If accepted, would result in no credible events leading to core damage for NuScale design (DBE and BDBE)
  - Retain core damage scenario for EPZ regardless of likelihood

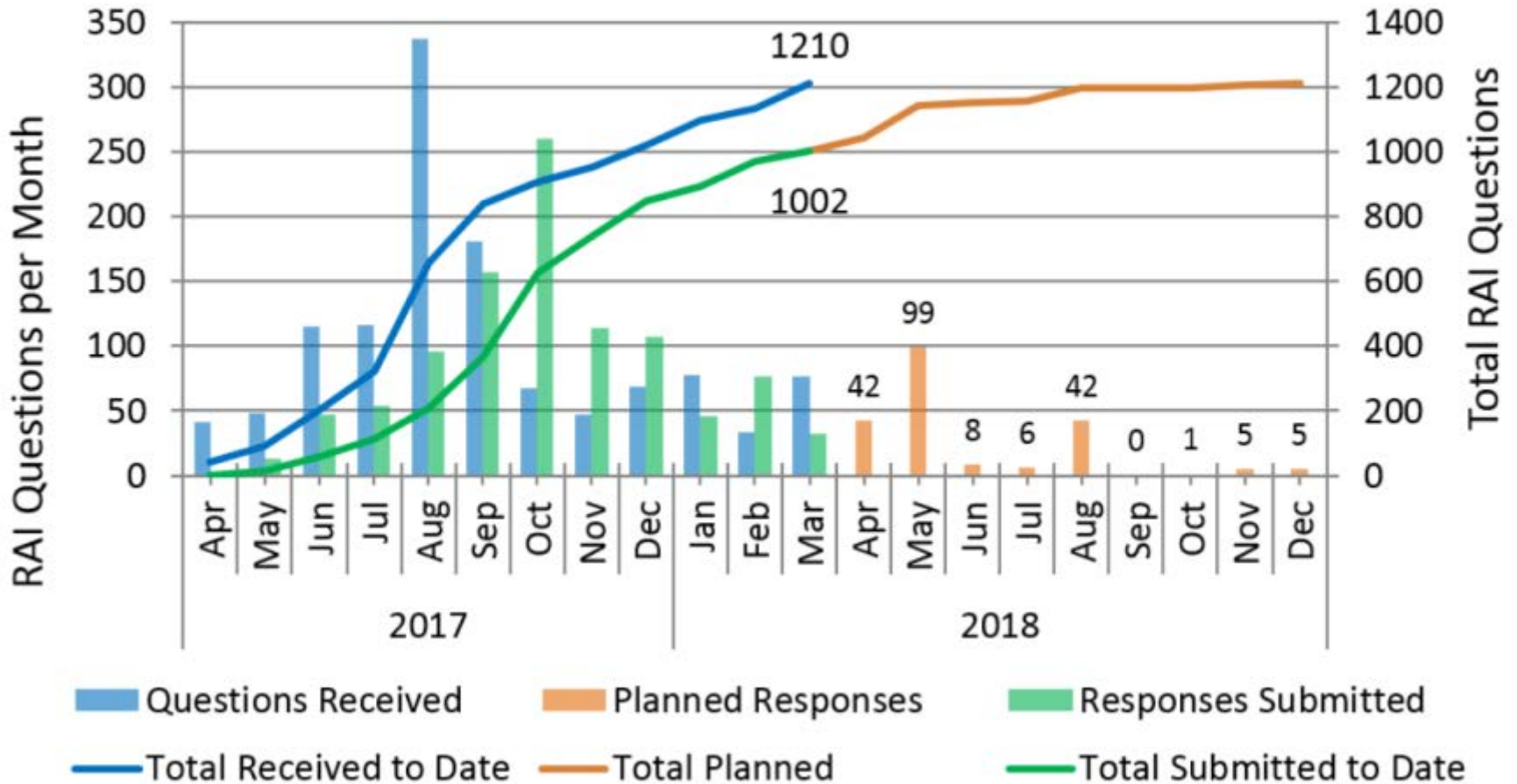


# Ensuring Review Progresses

- **Management Plans for key issue resolution**
  - Milestones – what, who and when will be accomplished
  - Get alignment with NRC at least monthly
- **Request for Additional (RAI) Information Metrics**
  - Track internal progress – update daily
  - Track NRC progress – align monthly
- **Licensing Audit progress**
  - Use of audit plans, periodic meetings, exit meetings
- **NRC Safety Evaluation Report progress**
  - Track changes in review phase at chapter level
  - Review drafts when available for proprietary review

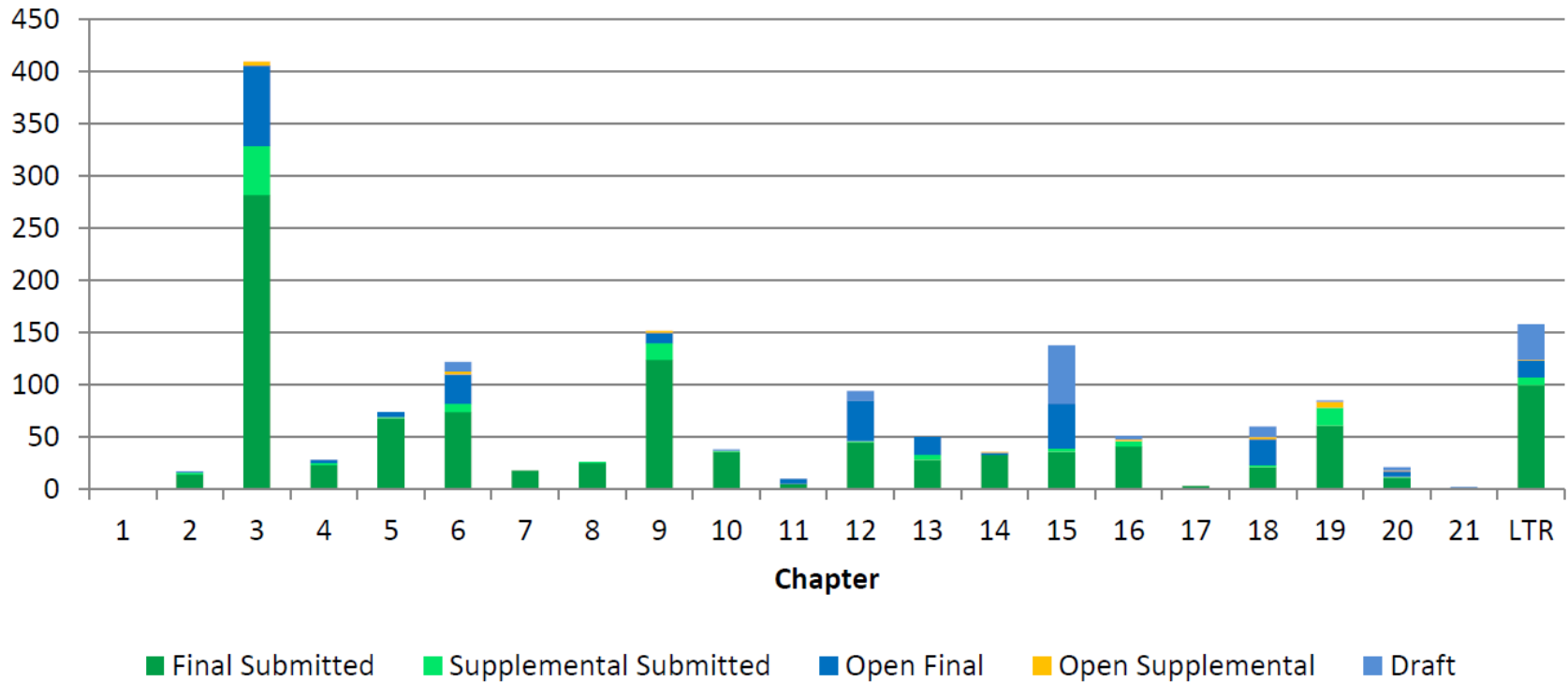
# RAI Metrics

## RAI Questions and Responses to Date



# RAI Metrics – Cont'd

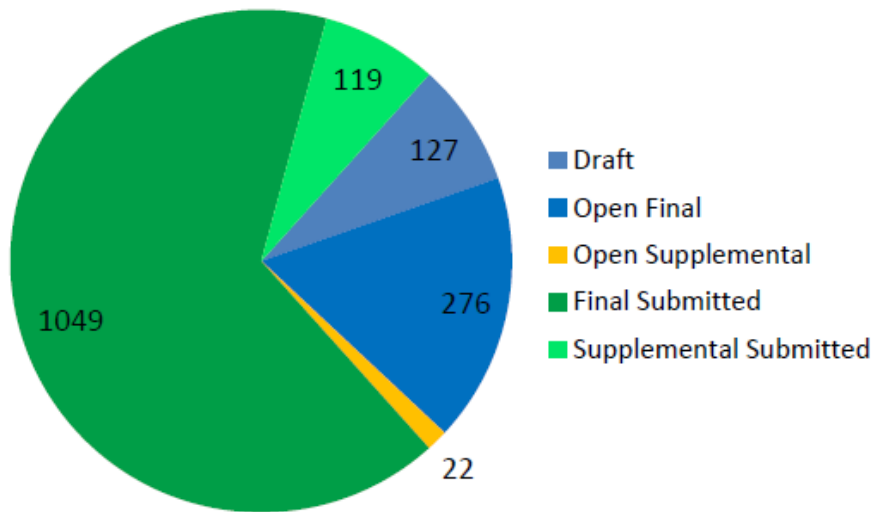
Number of RAI Questions by Chapter



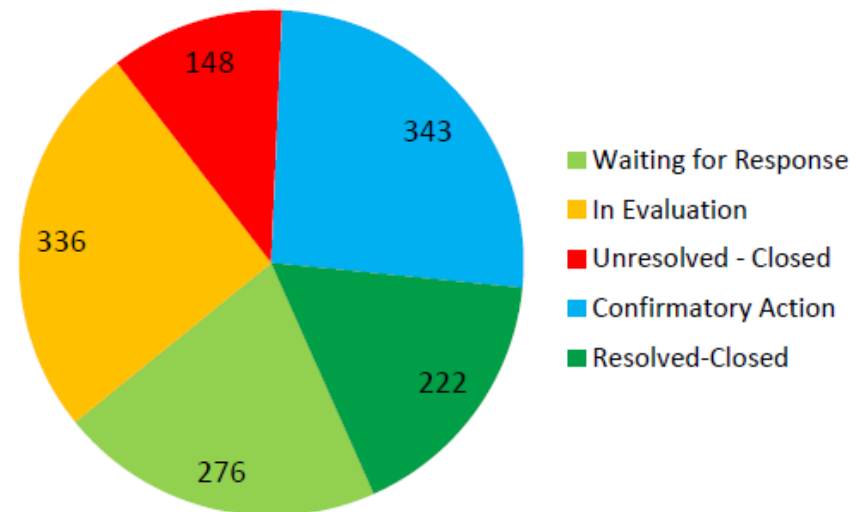
# RAI Metrics – Cont'd

## RAI Response Progress

### NuScale RAI Progress

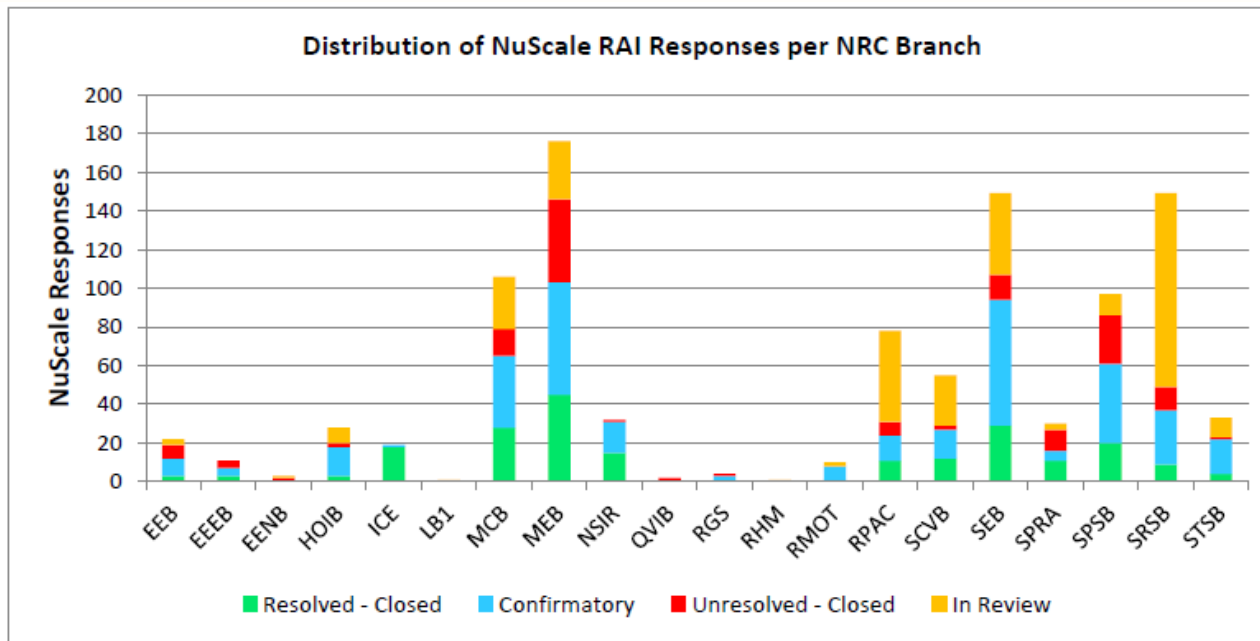


### NRC Review Status for RAI Responses



88% of Responses were Provided within 60 days

# RAI Metrics – Cont'd



Branch ID Glossary	
EEB/EEEB	Electrical Engineering Branch
EENB	Electrical Engineering New Reactors & License Renewal Branch
HOIB	Human Performance, Op. License & ITAAC
ICE	Instrumentation & Controls and Electronics Eng. Branch
MCB	Material & Chemical Engineering Branch
MEB	Mechanical Engineering Branch
NSIR	Nuclear Security and Incident Response
QVIB	QA Vendor Inspection Branch
RGS	Geosciences & Geotechnical Engineering Branch
RMET/RHM	Meteorology Team
RPAC	Radiation Protection & Accident Consequences
SCVB	Containment & Ventilation Branch
SEB	Structural Engineering Branch
SPRA	PRA & Severe Accidents
SPSB	Plant Systems Branch
SRSB	Reactor Systems, Nuclear Performance & Code Review Branch
STSB	Technical Specifications Branch

# EPZ Technical and Policy Issues

## ■ Technical

- Core damage frequency cut-off justification (“Black Swan”)
- Defense-In-Depth
- Near field source term dispersion
- External natural events
- Consistency with existing LLWR EPZ basis
- Accounting for analytical uncertainty
- Crediting non safety related SSCs
- Multi-module effects (if applicable)

## ■ Policy

- Alignment with SMR/ONT EPZ rulemaking
- Last line of defense and public protection consideration
- Public perception
- FEMA, state and local government dimensions

# Pre-Application NRC Engagement LL

- Document pre-application agreements to avoid staff and management turnover issues during the review
- Key agreements on DCA level of detail, content of B2 SSCs (e.g. BOP), and means of documenting NRC approval
- Focus on
  - Test Program
  - PRA
  - Simulator
  - Seismic/Structural
  - Unique Design Features - allow time for sufficient communication requires earliest scheduled multiple engagements
  - Regulatory Gap Analysis
  - Technical and Topical Reports (especially methodology)

# Pre-Application NRC Engagement LL

- Attendance at NRC Pre-Ap meetings
  - Right NRC and applicant technical and projects staff
  - NRC management
  - When policy-related, OGC
  - Document detailed meeting minutes; compare with and provide input to NRC meeting summary



# DCA Post-Submittal NRC Engagement

- **RAIs**
  - Appropriate regulatory basis and operating experience
  - Appropriate level of detail for a DCA and an NRC safety finding
  - Clarification calls for both technical and regulatory reasons
  - Document all NRC telecons
  - Track similar RAI responses by previous DCAs
- **Electronic Reading Room (eRR)**
  - Supports audits
  - Allows NRC access to read only, no printing, copying, or saving
- **Audits**
  - Focused scope in audit plan with control during audit execution
  - Reasonable schedule with defined documented milestones
  - Appropriate level of detail for DCA review and safety finding

# Licensing Advice to ARWG

- Closely follow NuScale RAIs and RAI responses
- Involve NRC in all ongoing and planned test plans and reports (e.g. topical, technical, white papers)
- Develop a pre-application engagement plan and vet it with the NRC
- Commit real resources to NEI initiatives (e.g., ITAAC and physical security)
- Obtain “high-fidelity” source documents with international experience on similar technology
- Obtain NRC agreement on IAEA SSC Classification

# Summary

- Overall NuScale's DCA review is going well
- NRC is executing its published schedule
- Generally appears to be improved NRC management discipline over review processes
- Further improvement in review processes can be achieved
- Clarification of review risks during pre-application critical

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## Summary of DOE Advanced Reactor Activities

NRC Public Meeting on Advanced Reactors  
May 3, 2018

Trevor Cook  
Manager, Advanced Reactor Licensing Program  
Office of Nuclear Energy  
U.S. Department of Energy

# DOE-NE MISSION AND PRIORITIES

## DOE-NE MISSION

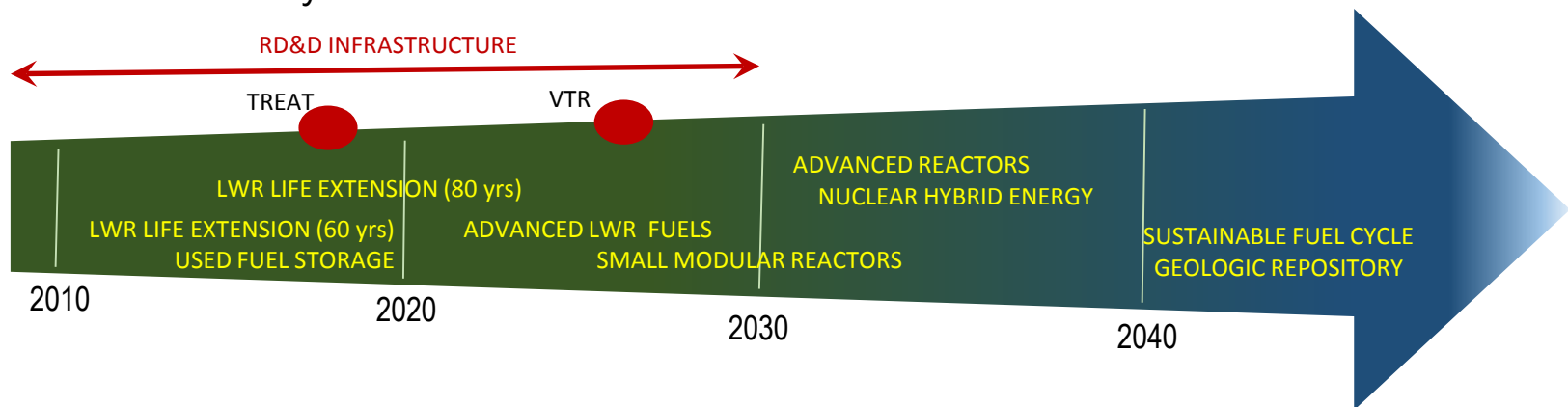
- Advance nuclear power as a resource capable of making major contributions in meeting our Nation's energy supply, environmental and energy security needs
- Seek to resolve technical, cost, safety security, and regulatory issues through RD&D
- By focusing on the development of advanced nuclear technologies, support the goals of providing domestic sources of secure energy, reducing greenhouse gases, and enhancing national security.

## MISSION PRIORITIES

Existing Fleet

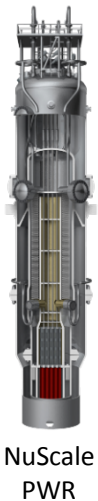
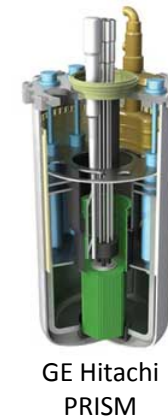
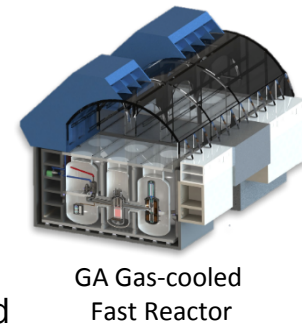
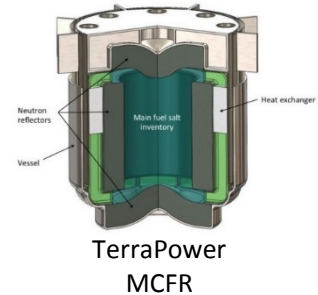
Advanced Reactor Pipeline

Fuel Cycle Infrastructure



# ADVANCED REACTOR TECHNOLOGIES FOCUS AREAS

- Advanced Light Water Reactors
- Fast Reactor Technologies
  - Demonstrate feasibility of advanced systems and component technologies
  - Methods and code validation to support design and licensing
  - Advanced alloy materials qualification for metal-cooled systems
- Gas Reactor Technologies
  - Advanced alloy and graphite materials qualification for high temperature gas-cooled systems
  - Scaled integral experiments to support design and licensing
  - TRISO-coated particle fuel development and qualification
- Molten Salt Reactor Technologies
  - Investigate fundamental salt properties
  - Materials, models, fuels and technologies for salt-cooled and salt-fueled reactors
- Cross-Cutting technologies
  - Advanced energy conversion
  - Supercritical Carbon Dioxide (sCO<sub>2</sub>) Brayton Cycle
  - Micro reactors for remote defense and commercial applications



# VERSATILE TEST REACTOR (VTR)

## IN SUPPORT OF ADVANCED REACTOR TECHNOLOGIES

### NEAC Advice:

- The need for a VTR was established through a series of independent surveys of the potential U.S. user community (industry, DOE programs) and support from international partners resulting in a NEAC report (“Assessment of Missions and Requirements for a new U.S. Test Reactor” 2/2017); it states that “The Ad Hoc NEAC subcommittee recommends that DOE-NE proceed immediately with pre-conceptual planning activities to support a new test reactor (including cost and schedule estimates).”

### Goals:

- 3 year R&D effort, along with appropriate reviews and planning, leading to an operational VTR by 2026
- VTR would support accelerated development of advanced fuels and materials for U.S. advanced reactor vendors, as well as to provide the capability for testing those fuels and materials to support licensing by the Nuclear Regulatory Commission.
- VTR with a high fast neutron flux would revitalize our research infrastructure and remove a critical impediment for U.S. developers of advanced nuclear energy technologies.
- Constructed and operated under DOE authority, in close collaborations with NRC.
- \$35 million in 2017 Omnibus Bill for versatile fast test reactor’s R&D activities to achieve CD-0 in January 2019.

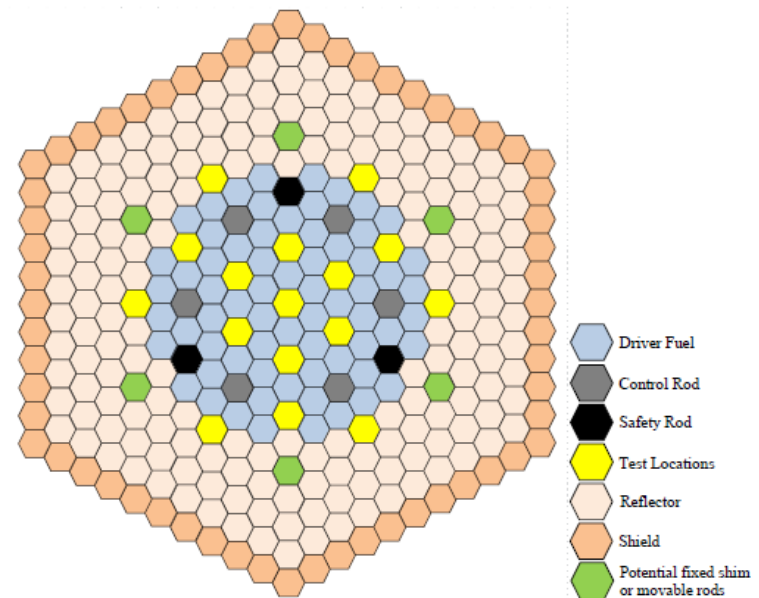


# DRAFT REQUIREMENTS/ASSUMPTIONS

## OF VERSATILE TEST REACTOR (VTR)

1. Approach to Design: Conducting a 3 year research & development effort on core design.
2. Reach fast flux of approximately  $4.E15$   $n/cm^2-s$ , with prototypical spectrum
3. Load factor: as large as possible (*maximize dpa/year to > 30 dpa/year*)
4. Provide flexibility for novel experimental techniques
5. Be capable of running loops representative of typical fast reactors (*Candidate Coolants: Na, Lead, LBE, Gas, Molten Salt*)  
– May be a single location with replaceable loops.
6. Effective testing height  $\leq 1$  m
7. Ability to perform large number of experiments simultaneously
8. Metallic driver fuel (possible options: LEU, Pu, LEU+Pu)

VTR draft core map



# NUREG-1537, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors*

## Overview of Proposed Revision for Nonpower Molten Salt Reactors

Randy Belles, ORNL

George Flanagan, ORNL

Marcus Voth, Boston Government Services

Advanced Reactor Meeting, May 3, 2018



# Development of nonpower MSR test facilities is under consideration to support the multiple analyses needed for development of full-scale MSRs

- Generates a need to look at the applicability of existing licensing guidance to non-power liquid-fueled molten salt reactors (MSRs)
- Presentation Outline
  - Background on NUREG-1537
  - Chapters proposed for revision
  - History of Aqueous Homogeneous Reactor (AHR) Interim Staff Guidance (ISG)
  - MSR issues and challenges
  - Summary of major changes to each chapter

# NUREG-1537 is used by an applicant or licensee of a non-power reactor for a new license, license renewal, or license amendment

- Covers all aspects of non-power reactor licensing (issued 1996)
  - No GDCs
  - No PRA
- Part 1 describes acceptable format and content of the safety analysis report (SAR) to be submitted to the NRC by an applicant or licensee
  - Corresponds to RG 1.206/RG 1.70 for commercial power reactors
- Part 2 gives criteria to assist NRC staff reviewers in performing comparable, complete, and consistent reviews of licensing applications
  - Corresponds to NUREG-0800 for review of LWRs

# NUREG-1537 content is similar to NUREG-0800

## Table of Contents

- 1 – Facility
- 2 – Site Characteristics
- 3 – Design of SSC
- 4 – Reactor Description
- 5 – Reactor Coolant Systems
- 6 – Engineered Safety Functions
- 7 – Instrumentation and Controls
- 8 – Electrical Power Systems
- 9 – Auxiliary Systems
- 10 – Experimental Facilities
- 11 – Radiation Protection and Waste Management
- 12 – Conduct of Operations
- 13 – Accident Analyses
- 14 – Technical Specifications
- 15 – Financial Qualifications
- 16 – Other Licensing Considerations
- 17 – Decommissioning
- 18 – HEU to LEU Conversions

# Most NUREG-1537 Chapters are applicable as-is

## Table of Contents

- 1 – Facility
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# NUREG-1537 Chapter 13, “Accident Analyses,” was considered for revision

- Chapter 13 subjected to a preliminary gap analysis review
- Determined that further design-specific accident analysis information is necessary
- Unfortunately, design-specific information is closely held by the active vendors
- Accident analyses for the Molten Salt Reactor Experiment is available and informative, but is not appropriate for all design variations
- Opted not to make any recommendations regarding Chapter 13

# Proposed MSR revision of NUREG-1537 is based on 2012 AHR Interim Staff Guidance

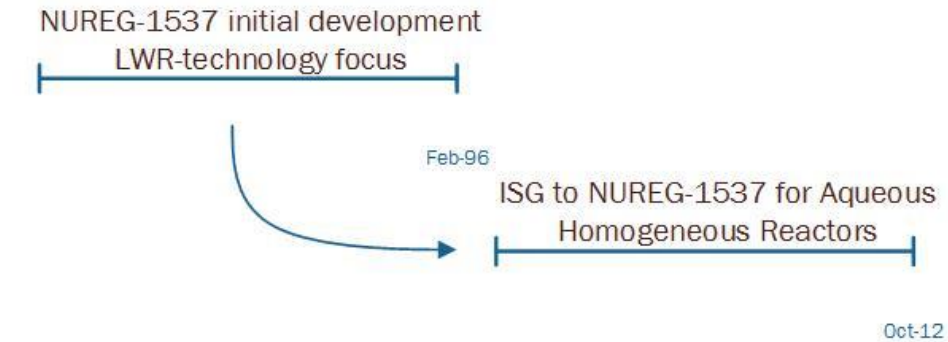
- In 2010 NRC initiated a multi-laboratory effort headed by BNL, supported by ORNL and ANL, to revise NUREG-1537 in anticipation of an AHR application to produce medical isotopes
- Several chapters (4,5,6,9 and 13) were deemed design specific and were revised by the laboratory team
  - Both volumes 1 and 2 were revised
  - Extensive revisions were required to address the unique aspects of AHR designs



# Report BNL 94462-2010 was submitted to NRC for consideration as an input for NUREG-1537 ISG

- NRC used report information as a basis for the NUREG-1537 ISG
- In 2012, NRC issued an ISG document for NUREG-1537 which contained revisions needed to review AHR submittals
- AHRs have several features similar to liquid-fueled MSR
  - Fuel is in a liquid form
  - Reactor vessel forms the first boundary to prevent release of fission products
  - Off gas systems collect and treat volatile fission products including noble gases
  - Systems for draining, refilling and polishing the fuel exist in AHRs
- MSRs have unique aspects not found in AHRs, so it was necessary to revise the ISG to reflect these features

# Proposed MSR update introduced issues to be addressed



## MSR Considerations:

4 - Reactor Description

5 - Reactor Coolant Systems

6 - Engineered Safety Features

9 - Auxiliary Systems

11 - Waste Management

Update non-power reactor guidance to accommodate MSRs

- AHR ISG influenced the proposed MSR update to NUREG-1537



ORNL/TM-2018/834

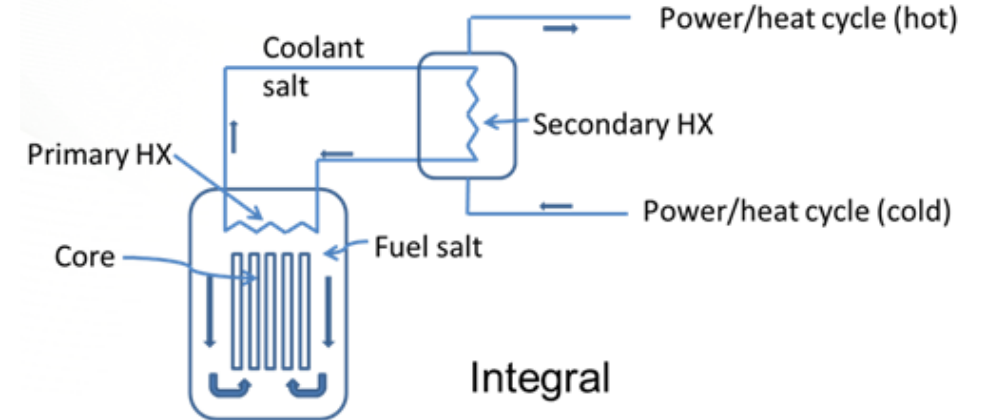
Limited distribution as  
ORNL/SR-2017/313-R1

# Retained same document format, but this led to some difficulties

- Current chapter content did not consistently conform to MSR technology
  - Fuel
  - Coolant
  - Heat transfer
- Unique MSR attributes were not covered
  - Arbitrarily inserted system and process discussions
  - May need to consider revised organization for a more optimized review
- No generic MSR design
  - Nothing is design-specific; designs protected by NDAs
  - Different salts and neutron spectrums to consider

# Generic MSR definitions are necessary

- Consistent system and component references
- Heat transfer loop references
- Proposed several fundamental process definitions for discussion:
  - Active Reactor Core
  - Coating
  - Control Element
  - Emergency Cooling System
  - Fission Product Barrier
  - Fuel Barrier
  - Fuel System Boundary



- Heat Dissipation System
  - Neutron Moderator
  - Primary Cooling System
  - Reactor Fuel
  - Vessel
- ANS 20.2, MSR Standard, will be the ultimate document for definitions

# MSRs have unique reactor control issues

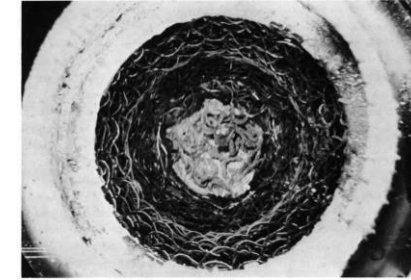
- Delayed neutron drift
  - Flowing fuel salt will cause some fraction of delayed neutrons to be born outside the active reactor core
  - Impact on ability to control the reactor
    - Flow changes
    - Fuel composition changes
    - Discussion – chapter 4
- Control elements
  - Act through fuel displacement, neutron absorption, neutron reflection, neutron spectral adjustment, or a combination of these methods
  - Solids, liquids, or gases
    - System discussion – chapter 4
    - System cooling – chapter 5 or 9 – no specific reference except in chapter 4

MSRE Control Elements  
Source: ORNL-4123



# MSRs are chemistry-based machines

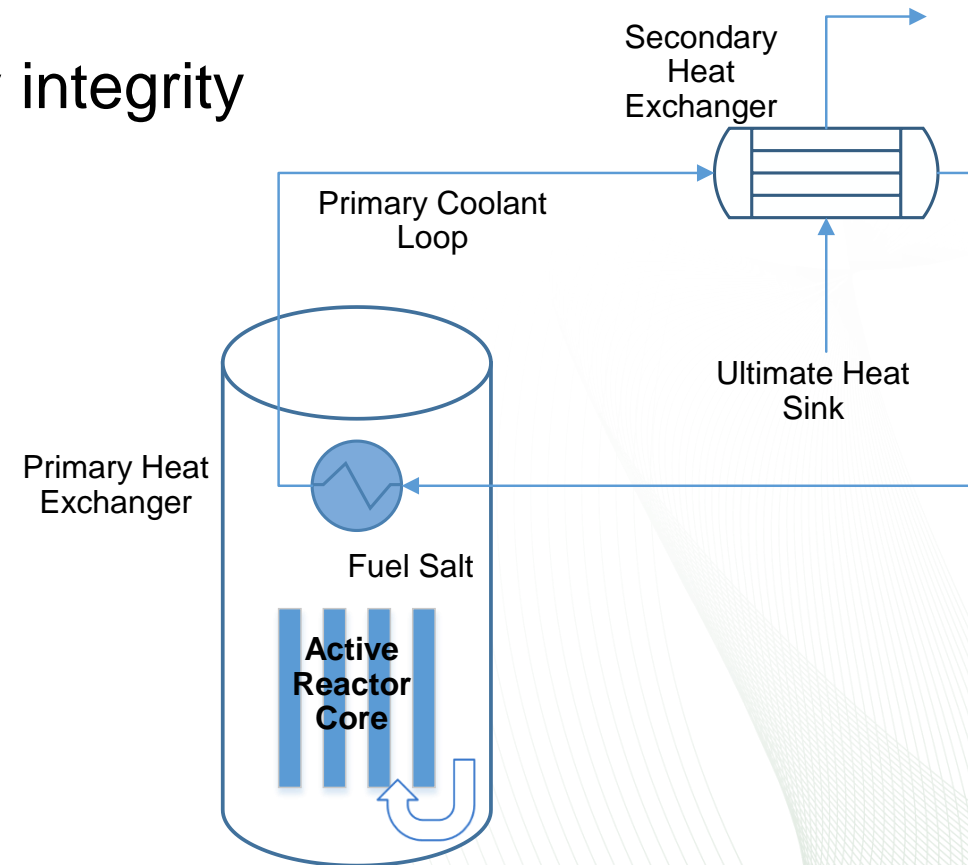
- Off gas from fission products
  - Affects core geometry/density/power
  - Leads to need for a gas management system
    - System discussion – chapter 4; System cooling – chapter 9
- Fuel cleanup or polishing system
  - Optional depending how designer chooses to address fission product poisons
  - Coordinates with online fuel additions, salt makeup, and fuel chemistry
    - Impact on fuel chemistry – chapter 4 under Nuclear Design
    - System description – chapter 5; System cooling – chapter 9
- Fuel salt chemistry
  - Need to understand the short-term and long-term changes in chemistry
  - Fuel Technical Specifications
    - Importance – chapter 4 under Reactor Fuel



MSRE Mark 1 Offgas Particle Trap

# MSR Reactor Description and Reactor Coolant Systems are Intertwined

- Fuel and coolant are a homogenous mixture
  - No cladding
  - Importance of fuel salt system boundary integrity
  - Fuel salt heat transport
    - Thermal-hydraulics – chapter 4
    - System description – chapter 5
  - Primary cooling system
    - System description – chapter 5
  - Heat Dissipation System
    - Ultimate heat sink
    - System description – chapter 5



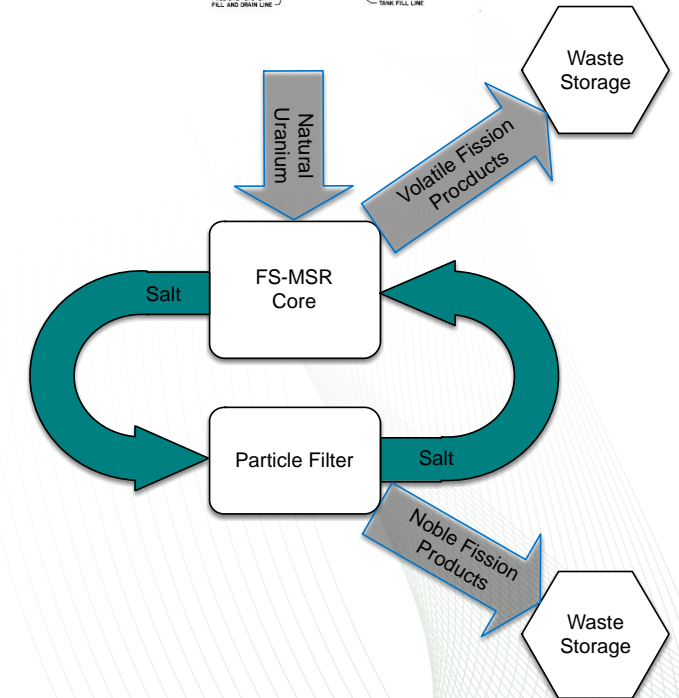
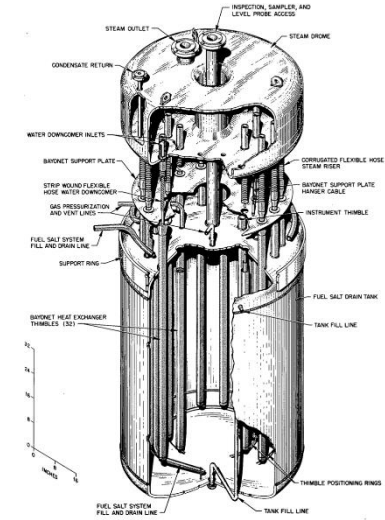
# Support systems must be considered

- Drain Tanks

- Need for maintenance and possibly as an ESF system (MSRE)
- Consideration for fuel salt and coolant salt
  - System discussion – chapter 5
  - System cooling – chapter 9

- Waste treatment and storage

- Describe process – no intention of producing special nuclear material (SNM)
- Production versus Utilization Facility
  - System discussion – chapter 11
  - System cooling – chapter 9





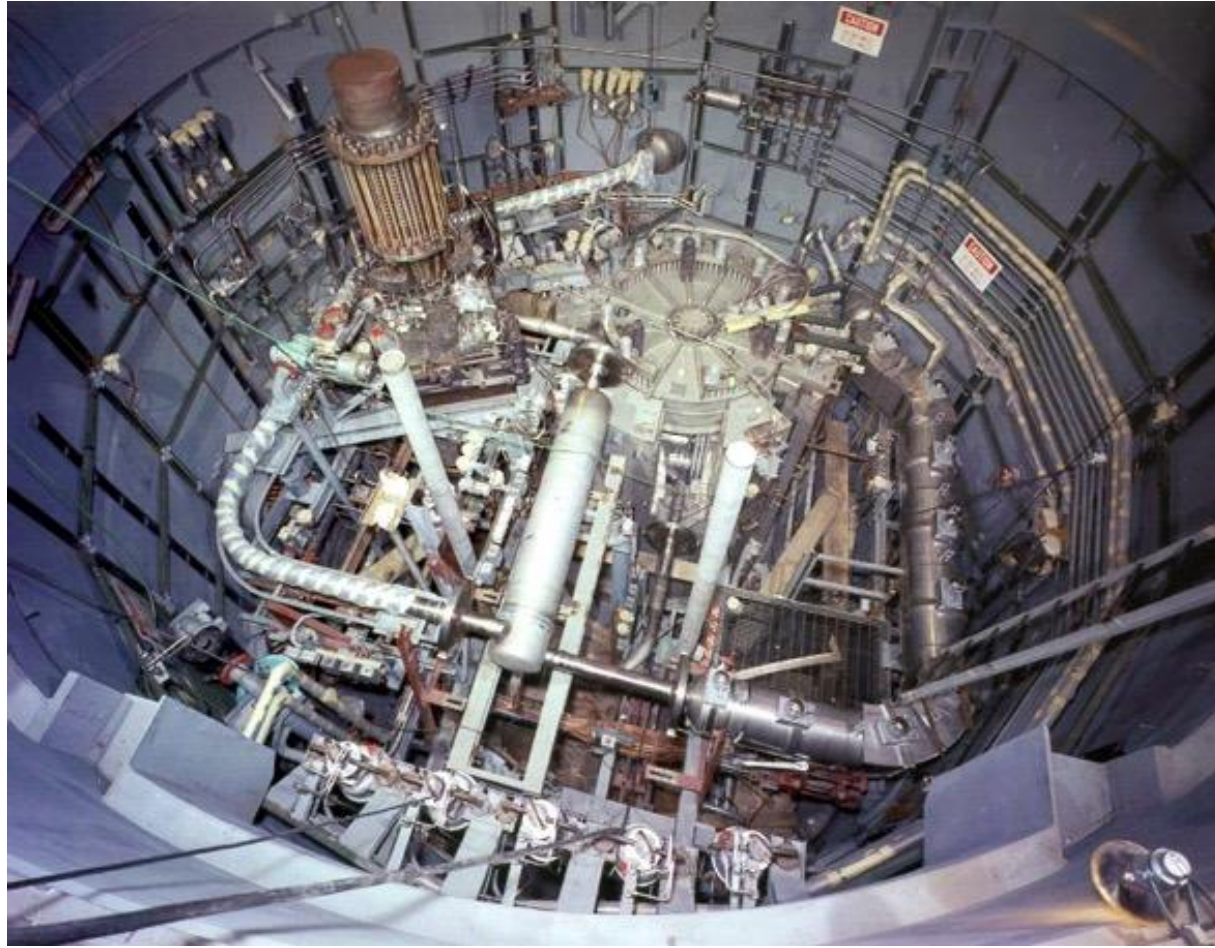
# Fuel handling presents challenges

- New and Used Fuel
  - Criticality concerns
  - Stability
  - Solid or liquid
  - Safeguards
  - Receipt, storage, dissolution, blending
    - System discussion – chapter 9
    - System cooling – chapter 9



ORNL Review

# Wrap-up with a brief look at the updated chapters



# The distinction between Chapters 4 (Reactor Description) and 5 (Reactor Coolant Systems) blurs for MSRs → chapter 4

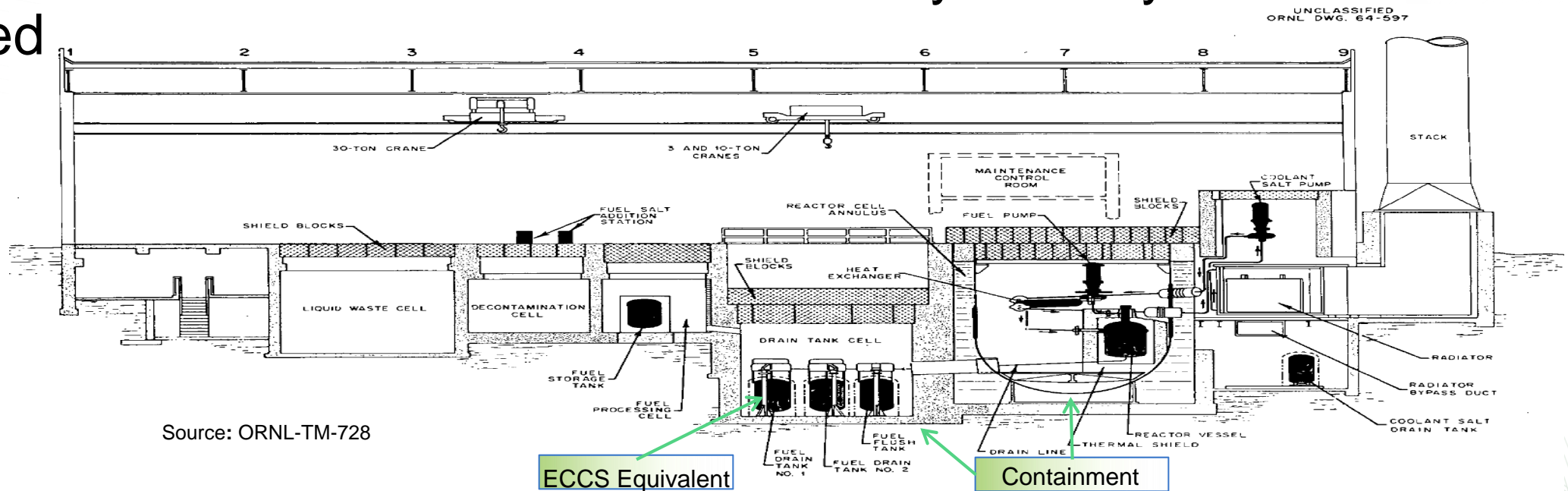
- Chapter 4 focus is on heterogeneous fuel elements consisting of fuel rods and fuel cladding acting as the initial fission product barrier
  - Protect the clad (AOOs) and maintain cooling (DBAs)
- MSRs operate with homogeneous liquid fuel and no cladding
  - Initial fission product barrier shifts out to the fuel salt boundary
  - Maintain the fuel salt system boundary
  - Control fuel salt chemistry / redox control
- MSR core conditions change over core life with fuel composition changes, fissile material buildup, and poisons
  - Use of control elements
  - Delayed neutrons
  - Gas management

# The distinction between Chapters 4 (Reactor Description) and 5 (Reactor Coolant Systems) blurs for MSRs → chapter 5

- Chapter 5 focus is on the transfer of heat from the heterogeneous fuel elements to the ultimate heat sink
  - Maintain cooling to assure fission product barrier remains intact
- The MSR fuel salt provides initial heat transfer to a coolant salt loop
- Fuel salt cleanup, salt makeup, fuel makeup considered
- Drain tank discussion added
  - Fuel salt loop
  - Coolant salt loop (primary cooling loop)

# Chapter 6 (ESF) equipment may simply consist of one or more containment structures

- Multiple confinement or containment boundaries might be included for an MSR design depending on the relative location of the gas management system and other cleanup systems
- DRACS or drain tank could be ESF or analyses may show none needed

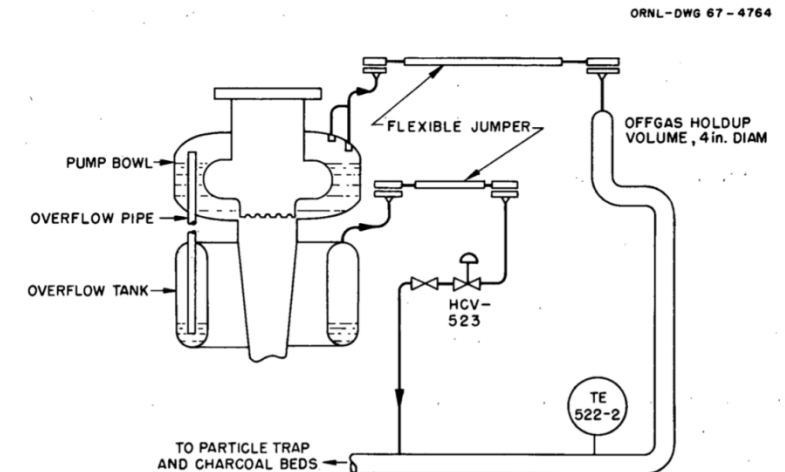


# MSR auxiliary systems discussed in Chapter 9 will need to evolve and expand to accommodate MSRs

- Consider MSR fuel handling and storage of SNM used for reactor fuel (both new and irradiated)
  - Systems (tanks, valves, pumps, instrumentation, controls), processes (chemical blending, SNM transfers, waste storage, preparation for shipment), criticality monitoring, vaults, shielding, and contamination control
- Quantity of byproduct, source, and SNM differ from the use of heterogeneous fuel elements
  - An effective means should be defined for limiting the SNM at the reactor site to establish an envelope used for safety and security analyses
  - The mission of a test MSR facility should be evaluated to determine limits on the quantity of byproduct materials created by experiments and routine operation
- Additional cooling systems should be described:
  - Gas management system
  - Drain tanks
  - Other design-specific systems

# Waste handling needs to be considered in Chapters 9 (Auxiliary Systems) and 11 (Waste Management)

- Once operated, MSR's will contain gaseous, soluble and non-soluble fission products in the fuel salt
- Some MSR designers will opt to remove gaseous and/or soluble fission products from the fuel salt
- Without careful consideration in the SAR, the separation of fission products could possibly be viewed as a colocated SNM fuel cycle facility
- This could lead to a complex licensing scenario
  - 10 CFR 50 utilization facility
  - 10 CFR 50 production facility (AHR ISG guidance)
  - 10 CFR 70 fuel cycle facility
  - What is the process? What is the intent?



Offgas Piping Near Pump and Overflow Tank

Source: ORNL-TM-3039

# Summary

- NUREG-1537 documents a performance-based approach for establishing design criteria and ensuring they are met
  - Based on more than 50 years of experience with commercial and nonpower reactors using heterogeneous fuel
- Adaptations for MSR technology must consider review processes that ensure the adequacy of proposed designs while recognizing the reduced operating experience with MSR designs
- Proposed update provides clarity for performance-based MSR review by removing some of the ambiguity created when transitioning from discussion of heterogeneous fuels to homogeneous fuels
- Proposed revisions will support DOE effort to assist MSR vendors with test facility licensing
  - Reduce regulatory uncertainty

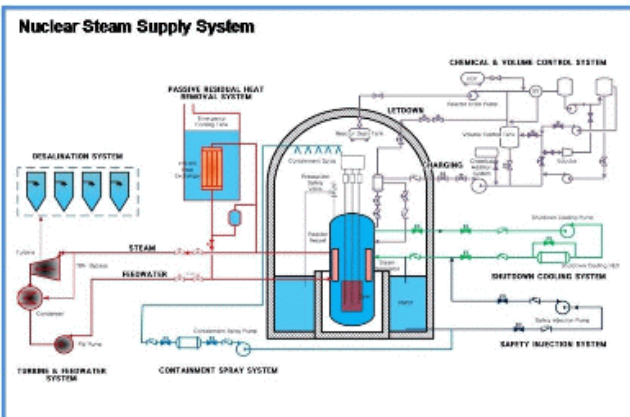




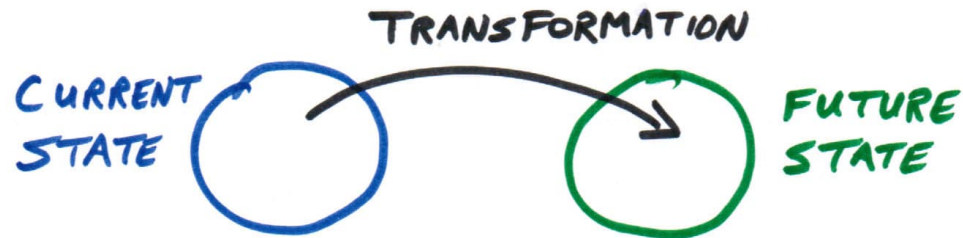
# Instrumentation and Controls: Safety-Focused Review Initiative

Advanced Reactors Stakeholders Meeting  
May 3, 2018

Ian Jung, Chief  
Instrumentation, Controls and Electronics Engineering Branch  
Division of Engineering and Infrastructure  
Office of New Reactors



# The staff is transforming I&C reviews



# The I&C regulatory infrastructure is not optimal for future designs

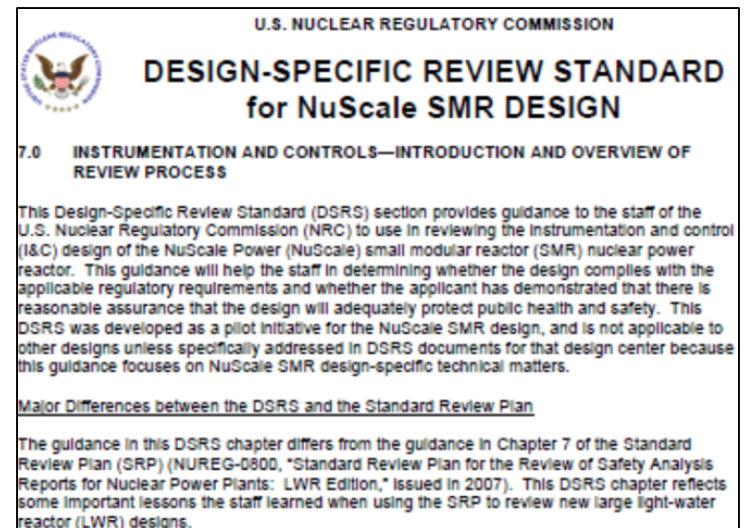
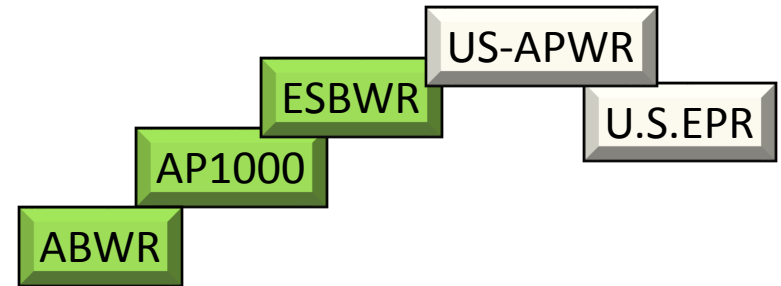
- Large light water reactors
- Increased complexity and volume
- Opportunities for safety focus, risk-informing, and simplicity



***What is the safety issue?***

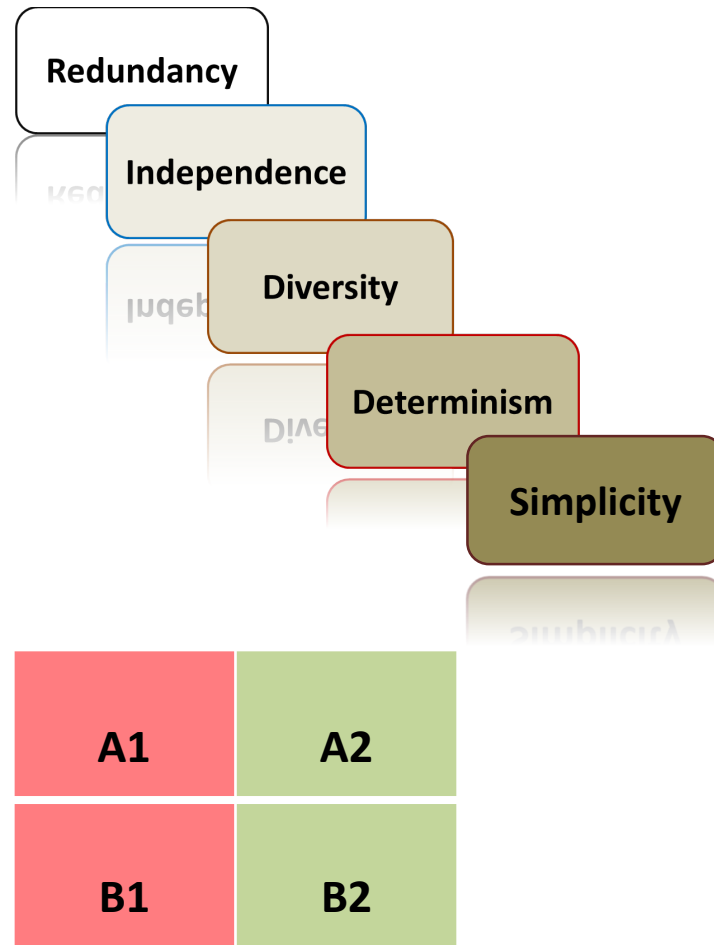
# The staff innovated its review approach for SMRs

- Lessons learned from reviews of other large light water designs
- Design-Specific Review Standard (DSRS) Chapter 7
  - “Grassroots”
  - SRM-SECY-11-0024
  - New
  - NuScale
  - Generically applicable
  - Mindset/cultural change
  - Cooperation with applicants



# DSRS Chapter 7 is simpler and more safety-focused

- Emphasis on fundamental design principles
- Risk-informed/safety focused review
- Removed inapplicable items and duplications
- Restructured staff guidance in NUREG-0800
- Lessons learned applied

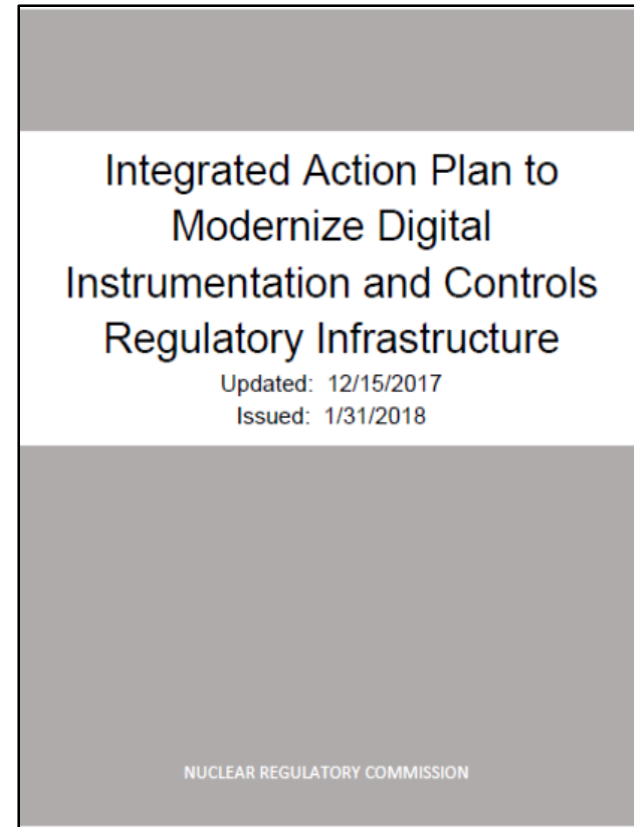


# The new approach has been a huge success for NuScale

- Highly effective
  - Demonstrated principles
  - Simplicity
  - Easily understandable/explainable
- Highly efficient
  - 95% reduction of RAIs
  - Significant reduction of staff hours and below the estimated
- Significantly ahead of schedule
- Applicant doing its part
  - Cooperation with staff
  - Cultural/mindset change

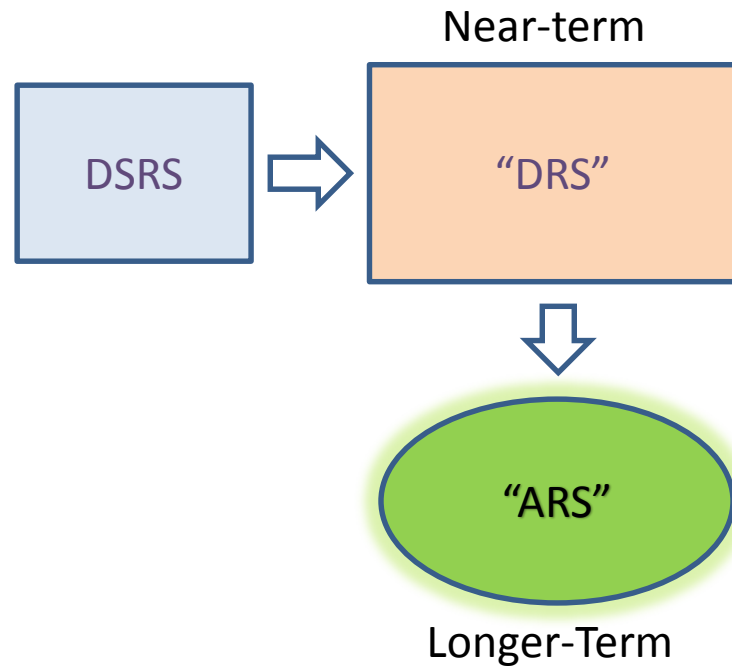
# The Commission directed the staff to “modernize”

- Integrated Action Plan
  - SRM-SECY-16-0070
- Regulatory infrastructure
  - “...simpler, streamlined, and agile... for new and advanced reactors.”
  - Principles/attributes, e.g.,
    - Performance-based
    - Technology-neutral
    - Consistent, durable, predictable, scalable
    - Unambiguous
    - Safe and secure



# The staff is getting ready for future designs

- Additional lessons learned and new opportunities
- New initiative started
  - Create new, improved guidance for future design reviews in a timely manner
  - Building on DSRS
- Close coordination
  - Advanced reactors
  - I&C modernization
  - Innovation and transformation at the NRC

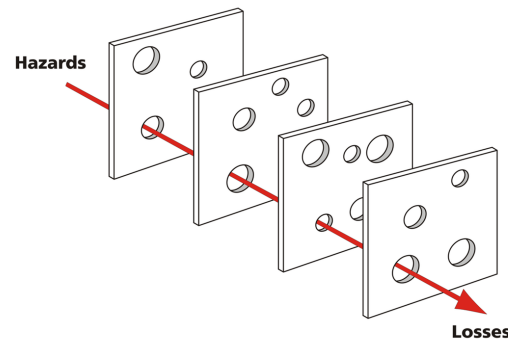




# The staff plans to issue “DRS” in time for advanced reactors

- Lessons learned from NuScale and APR1400
- More:
  - Risk-informed and performance-based
  - Safety focus
  - Technology-neutral
  - Principles-based
  - Agile/flexible
  - Efficient/predictable
- Balancing with defense-in-depth strategy

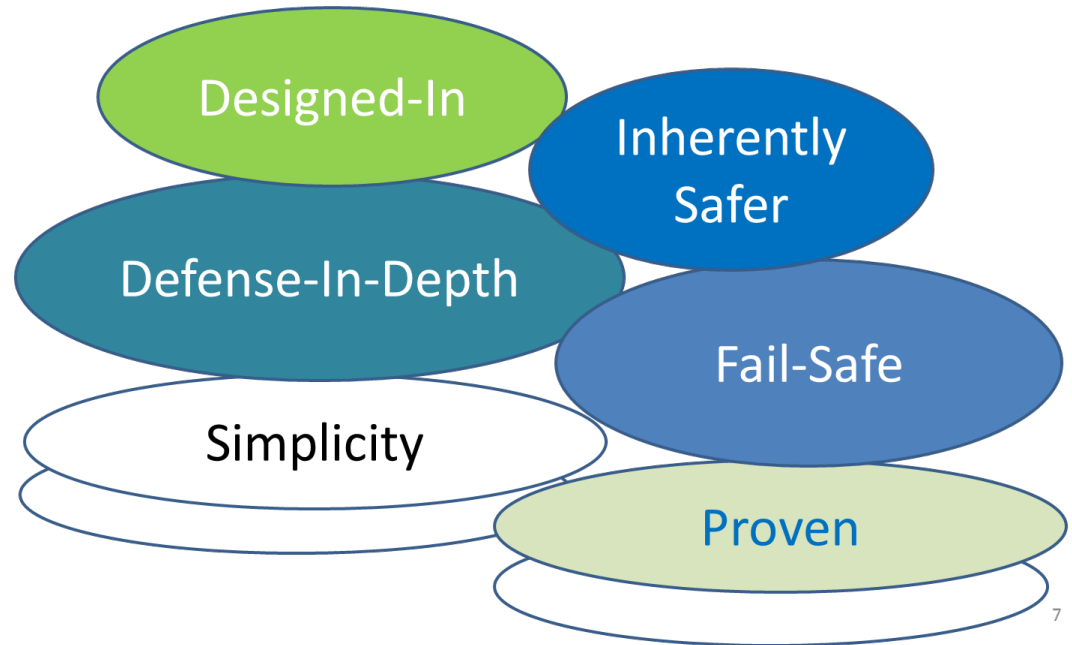
1. What can go wrong?
2. How likely is it?
3. What are the consequences?



# Success is ensured when...

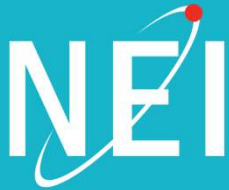
- Success factors
  - Cultural
  - Initiative
  - Applicant cultural/mindset change
- Fundamentals
  - Regulatory
  - Technical
- Principles
  - Safety engineering
  - Safety design

*If you do what you've always done, you will get what you've always gotten. -Tony Robbins*



# In summary

- The staff initiated an innovative, safety-focused approach for I&C reviews applying lessons learned
- The approach has been a huge success for NuScale
- The staff is further transforming I&C reviews for future designs
- The staff and stakeholders must work closely



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**Peter Hastings**

May 03, 2018

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**NRC STAFF  
COMMENTS ON  
REGULATORY  
ENGAGEMENT PLAN  
GUIDANCE DRAFT  
NRC Advanced Reactors  
Public Meeting**

# REGULATORY ENGAGEMENT PLAN (REP)

## INTRODUCTION

- Project scope: develop draft of REP template for industry and NRC review
- Approach
  - Informed by prior licensing project plans, annual new reactor planning Reg Issue Summaries
  - Guidance: FAQ-like descriptions of underlying elements of template, including options
- Overarching assumptions
  - Optional product
  - Flexible content & format



# REP GUIDANCE DRAFT

## NRC STAFF COMMENTS

- Comments received on draft revision 0M
- Vast majority of comments incorporated, including overarching comment that comprehensiveness of guidance document could be intimidating
- Few comments for discussion



# COMMENTS

- Developers should prepare a regulatory engagement plan as an early step in the overall program...[and] should pay particular attention to near-term activities needed to support the critical decision process...
  - Agreed; will include
  - Consistent caveats to reinforce REP as “optional”
- The regulatory engagement plan and the associated NRC review plan should define the expected outcomes from early interactions (e.g., initial, conditional, conclusive, or final) and related matters such as costs and schedules.
  - Agreed; will include
  - Clarify expectation for separate staff "review plan"



## COMMENTS (continued)

- Document...focuses more on licensing and the phase close to licensing rather than early engagement on pre-conceptual, conceptual, and preliminary designs. The staff encourages early interactions and don't want people to wait until close to the licensing stage.
  - Not the intent
  - Section 4 focused on pre-application engagement
  - Specific suggestion to increase emphasis?
- Pg 4, Sec 1.3: not clear whether paper suggests both RIS response and REP; staff prefers both
  - Industry prefers at least option not to "require" both
  - REP should not represent net increase in regulatory burden





## COMMENTS (continued)

- Pg 6: QA Program should reference NRC RG-1.28 Rev 5 (more recent than the NQA version cited in NEI 11-04A)
  - Will elevate existing footnote
  - Clarify NEI 11-04A is still valid point of departure
  - Other suggested edits helpful
- Pg 12: RG 1.70 is out of date, largely superseded by RG 1.206
  - RG-1.70 cited only for Part 50 applications
  - Discussion earlier on NRC's plans for transitioning to NUREG-0800/ RG-1.206
  - Will clarify benefit of additional discussion with staff for Part 50 application content



## COMMENTS (continued)

- Consider adding section on electronic submittals
  - Refer to Sec 5.2, second paragraph
- Sec 3.1, application type: adaptation of SRP does not comport with NEI “transformation” letter
  - Adaptation of existing guidance does not obviate new guidance in longer term; NEI letter not intended to delay modernized regulatory framework
  - Industry considers LMP to include adaptation of existing guidance
  - Existing guidance at least point of departure for design-specific changes
  - Document intended to suggest prospective applicants discuss topic early in pre-application engagement



## COMMENTS (continued)

- Pp 40/41 presumes staff will maintain 6-phase review, 42-month DCA review, and 30-month COLA review
  - Guidance document does not presume these
  - States explicitly:
    - Review typically is described in review phases
    - Baseline assumptions [for review schedules]...will vary as a result of design, NRC staff resource availability, etc
    - NRC staff's convention for review phases may change over time



# REP

## NEXT STEPS

- Incorporate NRC staff comments
- Address other minor editorial errors
- Publish guidance document



# QUESTIONS/COMMENTS





NUCLEAR ENERGY INSTITUTE

**Kati Austgen**

Sr. Project Manager, New Plant,  
SMR & Advanced Reactors

May 3, 2018

# ARRTF / SMRWG FEEDBACK ON SITING CONSIDERATIONS RELATED TO POPULATION

# RG 4.7 SHOULD BE UPDATED

- Important to enable expected benefit of EP rulemaking
  - Scale with source term, like emergency planning zones
  - Additional time to potential release
  - Much lower probability of such a release



# SCALE WITH **SOURCE TERM**

RG 4.7 population density guidance of less than 500 persons per square mile out to 20 miles could be adjusted to scalable guidance based on source term of SMRs and non-LWRs.

- **Smaller source term**
  - Scale up number of persons per square mile
  - Scale down the 20 mile radius for population density





# TIME TO **POTENTIAL RELEASE**

RG 4.7 population density guidance of less than 500 persons per square mile out to 20 miles could be adjusted to scalable guidance based on additional time to potential release for SMRs and non-LWRs.

- Longer time to potential release
  - Scale up number of persons per square mile
  - Scale down the 20 mile radius for population density



# PROBABILITY OF RELEASE

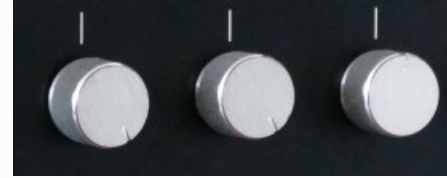
RG 4.7 population density guidance of less than 500 persons per square mile out to 20 miles could be adjusted to scalable guidance based on the much lower probability of release for some SMRs and non-LWRs.

- Much lower probability of release
  - Scale up number of persons per square mile
  - Scale down the 20 mile radius for population density



# RECOMMEND RG 4.7 UPDATE

- Important to enable expected benefit of EP rulemaking
- Opportunities for scalability of population density guidance
- Defense-in-depth achieved in design development
- We are gathering resources and assessing timing of next steps



May 2018 UPDATE: Policy Issues – Non-Light Water Reactors

Policy Issues – Non-Light Water Reactors		
Issue as presented on web page & previous meetings – raised questions related to applicability for LWR SMRs and non-LWRs		Updated Note/Status to specifically address activities related to non-LWRs
<b>Issues with Ongoing Activities for non-LWRs</b>		
License for Prototype Reactors	NRC staff drafting white paper	Action Complete Discussion incorporated (Enclosure 1) into NRC’s “A Regulatory Review Roadmap for Non-Light Water Reactors” ( <a href="#">ML17312B567</a> )
Appropriate Source Term, Dose Calculations, and Siting	SECY-16-0012, “Accident Source Terms and Siting for Small Modular Reactors and Non-Light Water Reactors,”	Parts of this topic related to Licensing Modernization Project (LMP) and other activities.  A draft white paper ( <a href="#">ML17333B158</a> ) related to siting in relation to population centers and population density discussed during December 14, 2017 and May 3, 2018 stakeholder meetings. <b>NEXT STEPS ?</b>
Key Component and System Design Issues		Related to LMP and white paper on SSC safety classification ( <a href="#">ML17290A463</a> ) and RIPB guidance document (report with staff comments – <a href="#">ML18120A321</a> )
Offsite Emergency Planning (EP) Requirements	SECY-15-0077 Drafting Regulatory Basis	Regulatory Basis ( <a href="#">ML17206A265</a> ) completed for the <a href="#">emergency preparedness rulemaking</a> with regard to small modular reactors and other new technologies. NRC staff preparing proposed rule and related guidance with planning milestone of providing to Commission by October 2018. <b>Agenda item for June 14<sup>th</sup> stakeholder meeting</b>
Insurance and Liability	Evaluating for periodic report to Congress on Price-Anderson Act	Issue discussed during November 2, 2017 stakeholder meeting, including presentation from American Nuclear Insurers. <del>Under review</del> <b>No short-term actions by NEI Advanced Reactor Working Group (ARWG) or other stakeholders;</b>

May 2018 UPDATE: Policy Issues – Non-Light Water Reactors

		NRC staff to prepare Commission paper for report to Congress and engage stakeholders during its development.
Use of Probabilistic Risk Assessment in the Licensing Process	SRP Revisions (safety focused review)	This topic is related to LMP and white papers/guidance ( <a href="#">ML17158B543</a> ). Also related to NRC participation in development of non-LWR PRA Standard (ASME/ANS) – see NRC response to NEI white paper ( <a href="#">ML17233A187</a> ) and RIPB guidance document (report with staff comments – ML18120A321)
Implementation of Defense-In-Depth (DiD) Philosophy for Advanced Reactors	SECY-15-0168 (part of licensing framework)	This topic is related to LMP and white papers/guidance ( <a href="#">ML17354B174</a> ), <del>NRC staff preparing comments and questions</del> and RIPB guidance document (report with staff comments – ML18120A321)
Security and Safeguards Requirements for SMRs	NRC White Paper	Current topic of interactions between NRC staff and stakeholders in context of NRC white paper ( <a href="#">ML17333A524</a> ) and discussions during public meeting on December 13, 2017 ( <a href="#">ML17354B266</a> ). NRC staff preparing Commission paper with expected completion in <del>early</del> mid 2018  NRC security design considerations issued for public comment ( <a href="#">NRC-2017-0073</a> ) and currently on hold.
Licensing Basis Event Selection	Ongoing discussions	This topic is related to LMP and submitted white paper ( <a href="#">ML17104A254</a> ) and related NRC staff comments/questions ( <a href="#">ML17145A531</a> ) and RIPB guidance document (report with staff comments – ML18120A321)

May 2018 UPDATE: Policy Issues – Non-Light Water Reactors

<p>Fuel qualification, materials qualification</p>	<p>Issues vary by fuel type and reactor technology</p>	<p>Ongoing discussions with advanced reactor technology groups and developers. This topic was discussed during August 3<sup>rd</sup> stakeholder meeting (<a href="#">ML17229B317</a>; slides <a href="#">ML17220A315</a>)  <b>Update ?</b></p>
<p>Fuel cycle facilities (front end)</p> <ul style="list-style-type: none"> <li>• Increased enrichments</li> </ul>	<p>Ongoing discussions</p>	<p>NEI provided a draft white paper on issues related to industry acquisition and use of higher assay low enriched uranium (HALEU) and fuel cycle facilities needed to support advanced reactors (<a href="#">ML17341A604</a>)</p> <p>The specific issues identified in the NEI white paper as needing NRC support are listed below along with current staff activities and/or planned interactions</p>

	<p>(1) Finalization of the Material Control and Accountability (MC&amp;A) rulemaking and associated regulatory guidance document (NUREG-2159) for Category II Special Nuclear Material (SNM).</p>	<p>See <a href="#">Supplement to Fuel Cycle Program Integrated Schedule - December 19, 2017.(ML17355A040)</a> for NRC status and NRC webpage <a href="#">Planned Rulemaking Activities – Rules</a>.</p>
	<p>(2) Development of guidance for implementing a Physical Security plan at a Category II SNM facility. This will require that the NRC and DOE to work together to finalize a consistent approach for addressing material attractiveness. Completing this work will enable determination of the need to continue with security rulemaking (10 CFR Part 73) and development of associated implementation guidance.</p>	<p>Staff activities currently on hold pending further Commission direction. See <a href="#">Supplement to Fuel Cycle Program Integrated Schedule - December 19, 2017.(ML17355A040)</a> and NRC webpages <a href="#">“Security-Related Rulemaking to Update 10 CFR Parts 73 and 26”</a> for NRC status and <a href="#">Planned Rulemaking Activities – Rules</a>.</p>
	<p>3) Collaboration with DOE and other involved parties on development of:</p> <p>(a) criticality benchmark data and</p> <p>(b) HALEU shipping package and transporter certifications.</p>	<p>NRC agrees that additional criticality benchmark data could facilitate criticality reviews. Decision on what criticality experiments to conduct is seen as an industry and DOE decision. Industry proposed design defines the data needs to support facility or transportation package design, DOE capability define the criticality experiments that can be conducted. NRC will collaborative with industry and DOE.</p> <p>NRC is prepared to review industry submitted shipping package and transporter applications.</p>

New Policy Issues - Warranting Immediate Actions?




May 2018 UPDATE: Policy Issues – Non-Light Water Reactors

<b>Policy Issues – Non-Light Water Reactors</b>		
Issue as presented on web page & previous meetings – raised questions related to applicability for LWR SMRs and non-LWRs		Updated Note/Status to specifically address activities related to non-LWRs
<b><i>Open Issues for non-LWRs but no current activities</i></b>		
Annual Fees	Final Rule (May 2016) - Annual fees scalable based on licensed thermal power rating, applicable only to LWR SMRs	Part 171 definitions: <i>Small modular reactor (SMR)</i> for the purposes of calculating fees, means the class of <b>light-water power reactors</b> having a licensed thermal power rating less than or equal to 1,000 MWt per module. This rating is based on the thermal power equivalent of a light-water SMR with an electrical power generating capacity of 300 MWe or less per module. Expect that changes will be needed to address non-LWRs
Manufacturing License Requirements	Pending determination of possible interest from non-LWR developers	SECY-14-0095 states no interest in obtaining a manufacturing license from near-term SMR applicants was expressed. Questions raised by stakeholders regarding possible approaches for non-LWRs given desire to use manufacturing/modular approaches
Industrial Facilities Using Nuclear-Generated Process Heat	SECY-11-0112 (assess as necessary)	Expect that additional guidance will be needed to address non-LWRs and possible process heat applications (also tied to siting and EP issues)
<i>Fuel cycle facilities (front in)</i>	<i>Ongoing discussions</i>	<i>One issue (increased enrichments) has been moved to ongoing activities portion of the table</i>
Waste Issues (back end)	Ongoing discussions	Generally deferred to NRC mid-term IAP activities pending specific needs/timeline for technology or design-specific licensing and deployment.

New Policy Issues - Not Warranting Immediate Actions?


May 2018 UPDATE: Policy Issues – Non-Light Water Reactors

<b>Policy Issues – Non-Light Water Reactors</b>		
Issue as presented on web page & previous meetings – raised questions related to applicability for LWR SMRs and non-LWRs		Updated Note/Status to specifically address activities related to non-LWRs
<b><i>Issues with no current plans to undertake activities (resolved or need input from stakeholders)</i></b>		
License Structure for Multi-Module Facilities	SECY-11-0079	Staff committed to provide Commission with a specific proposal using an actual SMR application for insights, status updated in SECY-14-0095
Operator Staffing for Small or Multi-Module Facilities	SECY-11-0098 (flexibility w/ existing guidance)	Long term solution to possibly include changes to NRC regulations (rulemaking), status updated in SECY-14-0095
Operational Programs for Small or Multi-Module Facilities	SECY-11-0112 (flexibility w/ existing guidance)	Confirmed in SECY-14-0095
Installation of Reactor Modules During Operation of Multi-Module Facilities	SECY-11-0112 (existing guidance)	Confirmed in SECY-14-0095
Decommissioning Funding Assurance	SECY-11-0181 (Site-specific exemptions)	Long term solution to possibly include changes to NRC regulations (rulemaking), status updated in SECY-14-0095
Aircraft impact assessments	Final rule ( June 2009)	Confirmed in SECY-14-0095