Presentations for May 3 & 4, 2017 Public Meeting
Regulatory Improvements for Advanced Reactors

May 3 AM (Discussion on Physical Security Requirements)

1) NRC Staff Opening Slides
2) Nuclear Energy Institute (NEI) Presentation; White Paper on Physical Security Requirements for Advanced Reactors (ADAMS Accession No. ML17026A474)
3) Union of Concerned Scientists Presentation

May 3 PM (Discussion of Licensing Basis Events

1) Licensing Modernization Project; White Paper on Selection of Licensing Basis Events (ADAMS Accession No. ML17104A254) and Probabilistic Risk Assessments
2) NRC Staff Backup Slide (Risk Informed Initiatives, Single Failure Criteria)

May 4 AM (Discussion of Probabilistic Risk Assessment

1) NRC Staff Opening Slides
2) Note that industry slides are continuation of package in May 3 PM session, starting on Slide 11
3) Idaho National Laboratory Discussion of Commission Policy on Containment

May 4 PM (Discussion of Licensing Basis Events

1) Nuclear Innovation Alliance, White Paper on "Major Portions" Project guidance for Standard Design Approvals (ADAMS Accession No. ML17128A507)
2) NRC Staff Slides on Policy Issues Update for non-light water reactors

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Public Meeting on Possible Regulatory Process Improvements for Advanced Reactor Designs

May 3 -4, 2017

Advanced Reactor Program

Public Meeting

- Telephone Bridge

  (888) 793-9929

  Passcode: 2985270
- Opportunities for public comments and questions at designated times

Outline – May 3 morning session

- Introduction
- Joint Discussions
  - NEI Physical Security White Paper
- UCS Views
- Public Questions/Comments

Outline – May 3 afternoon session

- Introduction
- Joint Discussions
  - LMP LBE White Paper
- Public Questions/Comments

Proposed Physical Security Requirements for Advanced Reactor Technologies

Tom Zachariah
Senior Project Manager
NEI

NUCLEAR ENERGY INSTITUTE

nuclear. clean air energy.

NEI White Paper (Dec. 2016)

- Proposes new physical security requirements for advanced reactors
  - Maintain same public protection standard
  - Supersedes Nov. 2015 white paper
- Addresses differences with large LWRs
  - Smaller cores/source terms
  - Enhanced engineered safety and security features
  - Use of different coolants (molten salt, gas, etc.)

NEI White Paper (Dec. 2016)

- Proposed requirements could be used if a design “performance capability” is met:
  - Technology is not susceptible to significant core damage and spent fuel sabotage, or
  - Does not have achievable target set, or
  - Design features allow implementation of mitigation strategies to prevent significant core damage and spent fuel sabotage

NEI White Paper (Dec. 2016)

- Regulatory and guidance changes are needed
  - Compliance with § 73.55 would impose an unnecessary regulatory burden
    - Diminishes cost competitiveness of new designs, thus hindering development and deployment
  - Should establish a clear, predictable and stable licensing process
    - Avoid inefficiency and uncertainty associated with alternative measures, exemptions and license conditions

NEI White Paper (Dec. 2016)

- We would like to:
  - Answer staff questions about the proposed changes presented in white paper
  - Discuss a potential path forward to realize the goals of the white paper

UCS Objections to the NEI Security White Paper

Edwin Lyman
Senior Scientist
Union of Concerned Scientists
May 3, 2017

No basis for this rulemaking

- The white paper proposes a rulemaking that would allow the NRC, for advanced power reactors that meet certain conditions, to waive the requirement for
  - an armed response force capable of interdicting and neutralizing threats up to and including the design basis threat (DBT) of radiological sabotage
  - security performance evaluations
- In our view, there is neither a technical basis nor a policy justification for this reckless proposal
  - Any nuclear reactor can be sabotaged and any target set component can be defeated, one way or another; this rule could lead to endless disputes about what is or isn't "achievable" by the adversary
  - Reliance on off-site local law enforcement and operators using FLEX equipment to mitigate an attack introduces multiple uncertainties in the assessment of compliance with the proposed rule; reliable prevention measures would be exchanged for highly speculative emergency response and mitigation measures

Advanced reactor vulnerabilities

- Non-LWR nuclear reactor designs have vulnerabilities that could be exploited by attackers to cause radiological sabotage, although the strategies may be different than for LWRs
  - Liquid-metal cooled fast reactors have reactivity instabilities and flammable coolant
  - Gas-cooled reactors can be seriously damaged by air or water ingress
  - Molten-salt reactors must be kept within a narrow temperature range to prevent freezing of the coolant or rapid destruction of the reactor (within ten minutes)
- Few, if any, non-LWR designs have accurate and well-validated PRAs or even a well-defined design-basis accident spectrum

Achievable target sets

- Advanced reactors would qualify for reduced security requirements if they do not have a target set that is "achievable" by the design basis threat adversary
- This determination would have to be made by subject matter experts
  - Increased consideration of ability of insiders to compromise engineered security barriers

Mitigation

- Instead of maintaining reasonable measures to prevent attacks, the white paper would allow attackers to destroy a complete target set, based on the unverifiable belief that local law enforcement would be able to clear the site of attackers and allow site personnel to implement mitigation strategies in time to prevent significant core or spent fuel damage
  - No performance evaluations required
- Adversaries may be able to cause damage in ways that would challenge assumed timelines for core damage and mitigation
  - FLEX is only designed to mitigate one particular accident scenario (extended loss of AC power and loss of heat sink)
- White paper also appears to suggest rulemaking should include these options for operating reactors; would contradict the premise that this provision is only for advanced reactors with additional engineered safety and security features

MOX fuel protection

- The white paper would preserve the extra provisions in §73.55(l) for MOX fuel security at power reactors while getting rid of the armed response force
- Yet those provisions are **predicated** on the presence of an armed response force that is capable of executing a protective strategy to interdict and neutralize the radiological sabotage DBT (and even then they are inadequate)
- Reactors using Category I materials that do not meet the §73.55 exemption criteria (< 20 wt-% Pu)* would continue to require armed response for protection against the theft DBT

** Current MOX fuel threshold will have to be reconsidered given the different proposed threshold for moderately dilute Category I material (10 wt-% Pu) in the technical basis for the "enhanced security" rulemaking*

Regulatory efficiency

- The white paper argues that a rulemaking would be more efficient to address these issues than case-by-case exemptions
- It is not clear that the analysis the rule would require would involve any less effort than that needed to evaluate exemption requests in individual plant licensing

Conclusions

- UCS strongly disputes the fundamental premises of the NEI security white paper
- The white paper consists of little more than wishful thinking
- The white paper has not presented a single credible example of an advanced reactor that would not be susceptible to significant core damage or spent fuel sabotage
- The NRC has neither the time nor the resources to waste on rulemakings that deal with science fiction
- The NRC should decline to give the white paper any further consideration

Utility-Led Initiative for Licensing Modernization of Technical Requirements for Licensing of Non-Light Water Reactors

White Papers for LBE Selection and PRA Development

May 3-4, 2017 • USNRC Rockville MD

Overview of Sessions

- Wednesday May 3, 2017 LBE White Paper
  - LBE White Paper Overview
  - NRC Questions
  - Discussion
- Thursday May 4, 2017
  - PRA White Paper Overview
  - NGNP Perspective on Siting Event Selection

LICENSING BASIS EVENT SELECTION WHITE PAPER

Karl Fleming

LBE Selection Attributes of this project

- Systematic and reproducible process
- Sufficiently complete set of LBEs
- Timely input to design decisions
- Risk-informed and performance-based
- Reactor technology inclusive process
  - Capable of identifying reactor specific safety issues
  - Applicability to wide range of non-LWR concepts
  - Uniform level of safety across deigns
- Consistent with applicable regulatory requirements

Categories of LBEs

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

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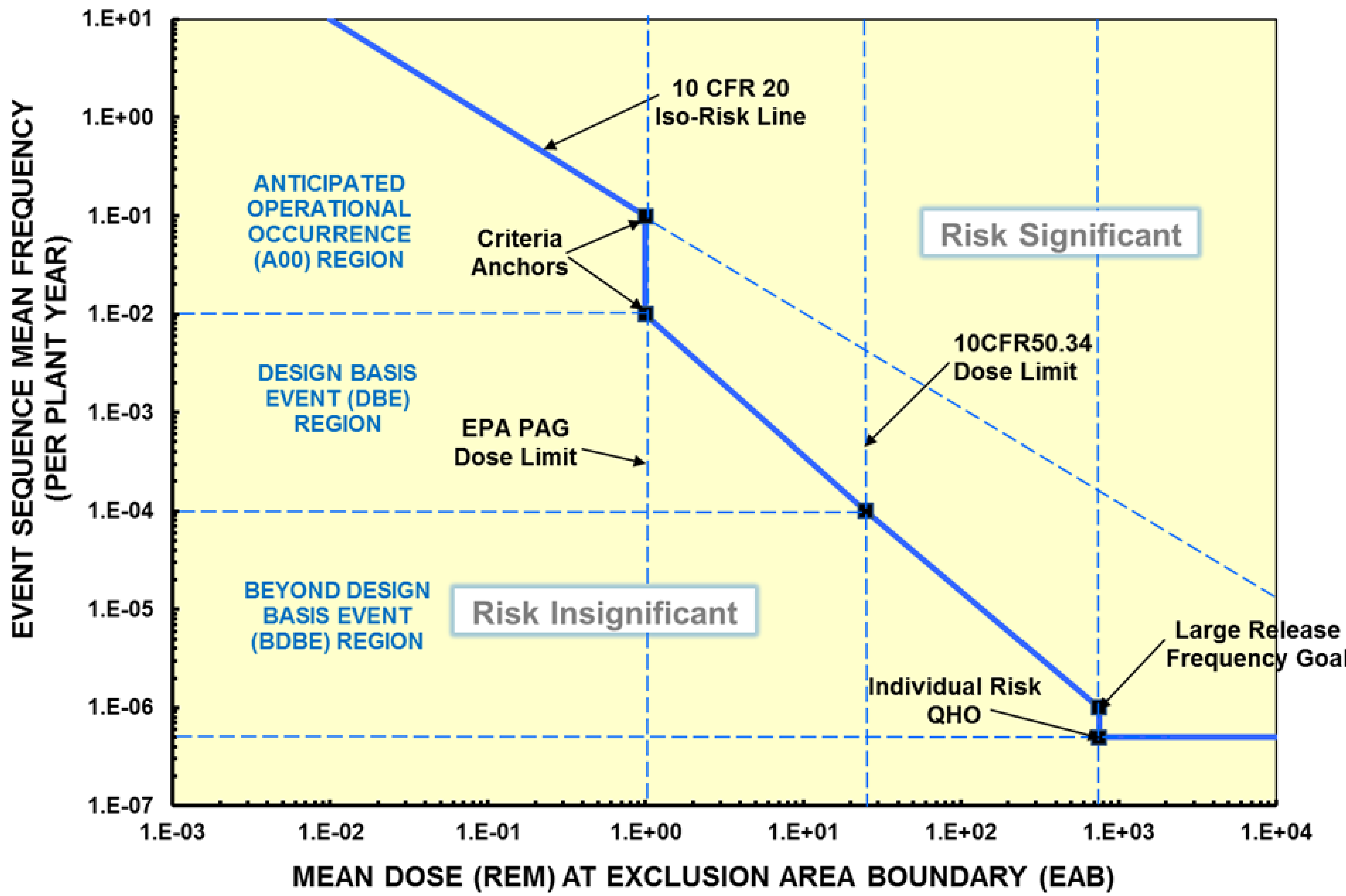
Process For Selecting and Evaluating LBEs

Frequency-Consequence Evaluation Criteria Proposed for LMP



Risk Evaluation of LBEs

- Purpose of TLRC F-C criteria is to evaluate the risk significance of individual LBEs
- Integrated plant risks must also satisfy cumulative risk criteria
  - QHO for early fatality individual risk
  - QHO for latent cancer fatality individual risk
  - Safety Goal for Large release frequency
  - Annual exposure limits per 10 CFR Part 20

DISCUSSION TOPICS

- TLRC Frequency Consequence Criteria
- LMP Process Flow and Tasks
- LBE Examples for MHTGR
- LBE Examples for PRISM
- Path Forward

QUESTIONS?

PRA WHITE PAPER

Karl Fleming

Discussion Topics

- PRA White Paper objectives
- Technical issues and challenges
- PRA development plan (roadmap)
- White paper development approach

PRA White Paper Objectives

- Assist NRC to develop regulatory guidance for licensing advanced non-LWR plants.
- Present a technology inclusive approach to developing a PRA for advanced non-LWRs and to ensuring its technical adequacy

Additional PRA Objectives

- Support a full range of RI-PB decisions
  - Evaluation of design alternatives and incorporation of risk insights into the design
  - Input to the selection of licensing basis events (LBEs)
  - Input to the safety classification of systems, structures and components (SSCs)
  - election of special treatment and performance requirements for the capabilities, and reliabilities for SSCs in the prevention and mitigation of accidents
  - Risk-informed and performance based evaluation of defense-in-depth adequacy.
- Provide an approach that can be applied to known advanced non-LWRs including HTGRs, LM cooled fast reactors, molten salt reactors
- Provide roadmap for performing and upgrading the PRA as the design matures
- Define the approach to ensuring PRA technical adequacy

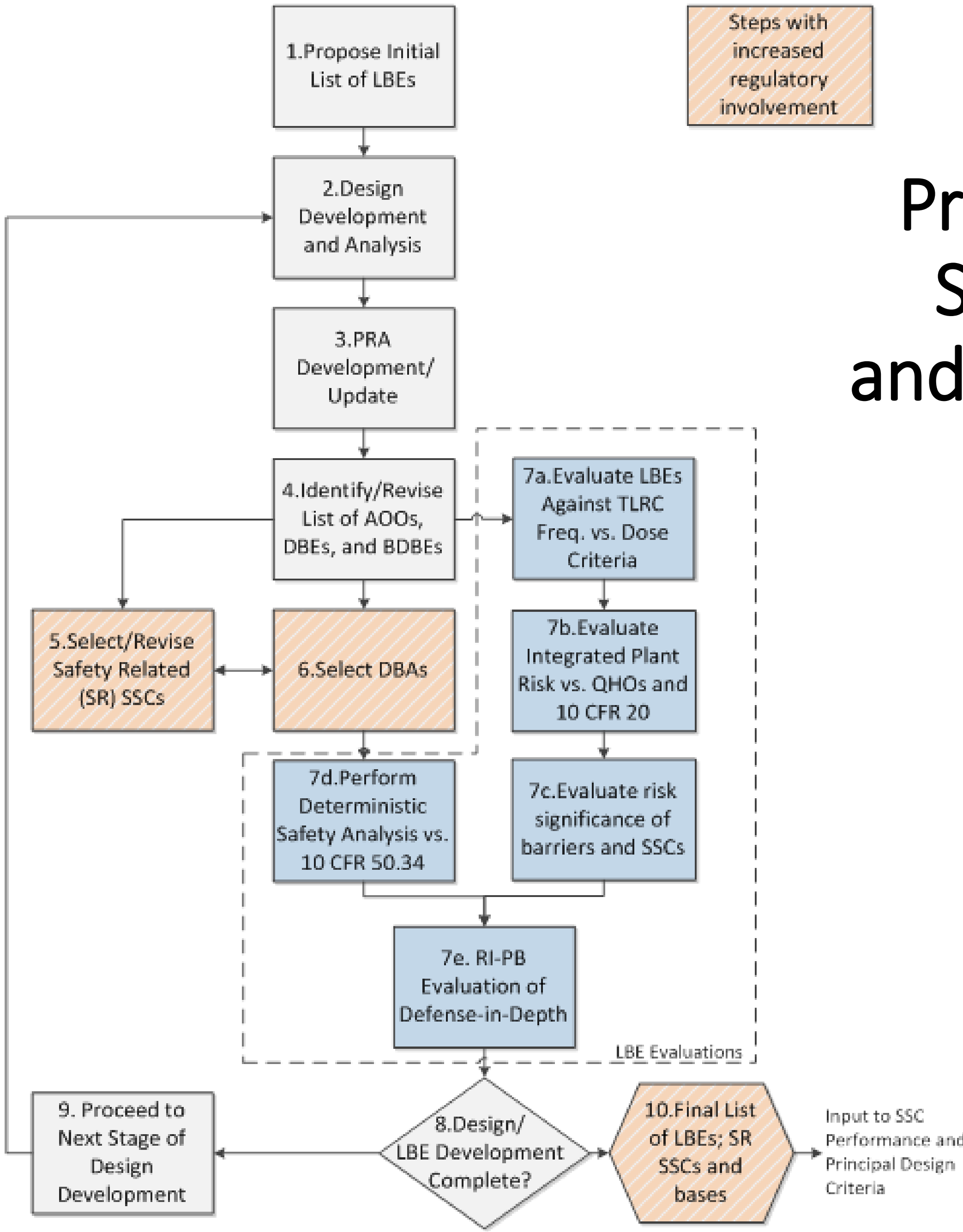
THE PRINCIPAL CHALLENGES

- Varying degrees of lack of experience with non-LWR PRA
- Lack of design and operational details for pre-operational PRA development
- Lack of service experience to support PRA data for unique events and components
- Increased reliance on inherent safety features and passive systems
- Increased scope of PRA to support LBEs within and beyond design basis
- New risk metrics appropriate for non-LWRs and multi-module designs
- Need to develop risk management strategies for multi-module and multi-source accidents
- Lack of experience for staff peer review teams.
- Need to address insights from PRA pilots for ASME/ANS PRA (Trial Use) Standard for Advanced non-LWRs

PRA Development Plan Concept

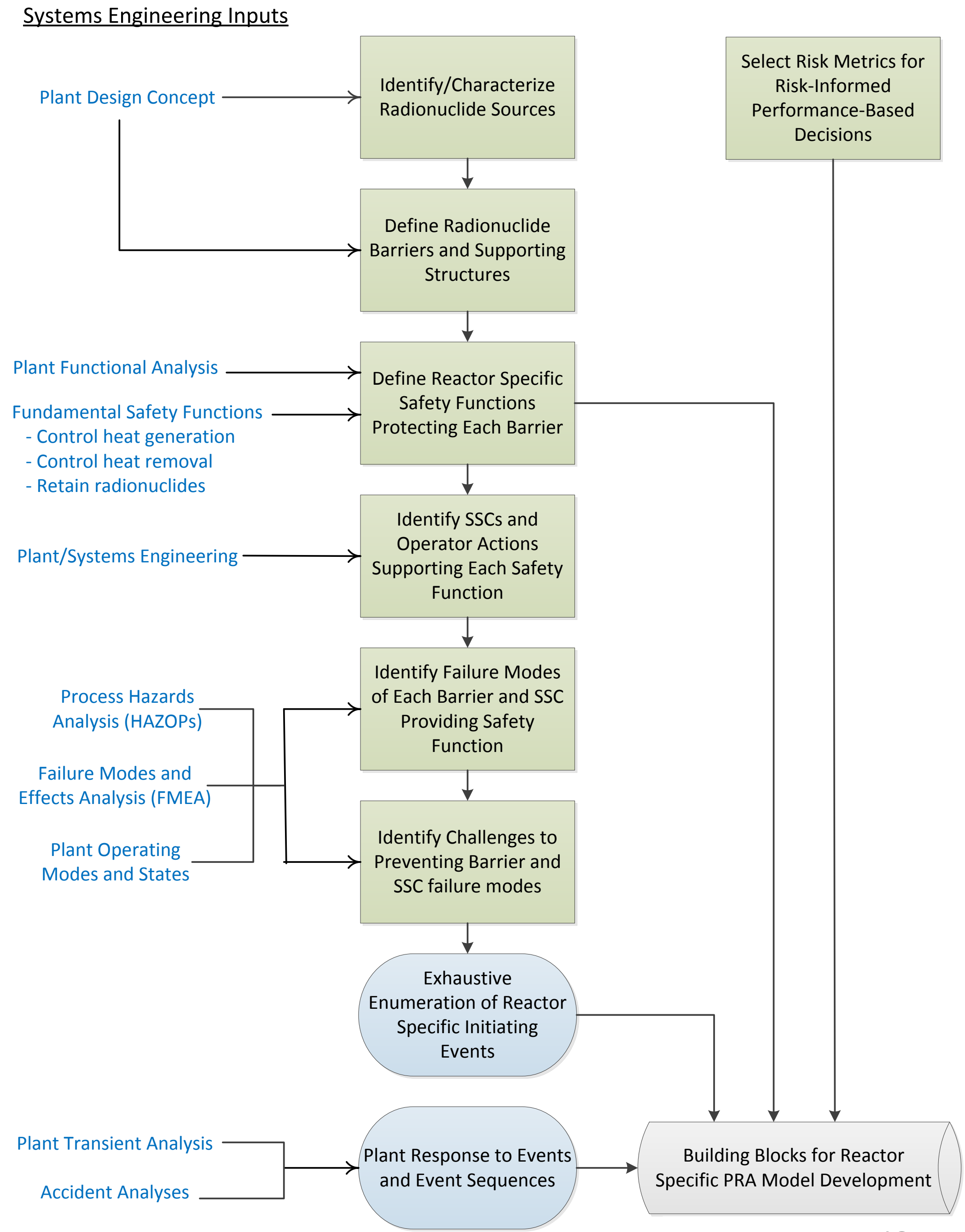
- PRA will be developed in stages keyed to evolution of design, operation and maintenance requirements, and site characteristics
- Level of detail and completeness consistent with that of the design
- Risk-informed decisions supported by the PRA will be made and updated in an iterative fashion as the design and PRA matures
- PRA models, success criteria, plant transient response to events, mechanistic source terms, and offsite consequences initially based on assumptions and replaced by supporting analyses as the analysis tools become available
- The design and PRA phases will likely be different for different non-LWRs depending on PRA history for each reactor

Process For Selecting and Evaluating LBEs



Flow Chart for Initial PRA Model Development

- Expands on Steps 2 and 3
- Risk metrics and criteria for LBE evaluation defined in Step 7
- Focus is on early stages of design and PRA development



Technical Issues Addressed

- Technology inclusive risk metrics and risk importance measures
- PRA treatment of multi-module and multi-source accidents
- Technology inclusive approach for defining PRA modeled safety functions in terms of barrier protective functions
  - Application of approach to MHTGR and PRISM

Risk Importance Metrics

Measure	Abbreviation	Principle
Risk reduction	RR	$R(\text{base}) - R(x_i = 0)$
Fussell–Vesely	FV	$\frac{R(\text{base}) - R(x_i = 0)}{R(\text{base})}$
Risk reduction worth	RRW	$\frac{R(\text{base})}{R(x_i = 0)}$
Criticality importance	CR	$\frac{R(x_i = 1) - R(x_i = 0)}{R(\text{base})} \times x_i(\text{base})$
Risk achievement	RA	$R(x_i = 1) - R(\text{base})$
Risk achievement worth	RAW	$\frac{R(x_i = 1)}{R(\text{base})}$
Partial derivative	PD	$\frac{R(x_i + \partial x_i) - R(x_i)}{\partial x_i}$
Birnbaum importance	BI	$R(x_i = 1) - R(x_i = 0)$

R = CDF, LERF, or Technology Inclusive Risk Metric, e.g. QHOs

Risk Metrics Supported by PRA

- Reactor Specific Metrics
  - User defined metric, e.g. frequency of sodium boiling for SFRs
  - LBE Frequencies and consequences
- Technology Inclusive Metrics
  - Individual and societal QHOs
  - Exceedance frequencies of specific site boundary doses (e.g., LRF, 10 CFR 20)
  - Exceedance frequencies of offsite health effects

Multi-Module PRA Guidance

Category	Reference
Non-LWR Case Studies	MHTGR PRA (4 Reactor Modules) PRISM PRA (2 Reactor Modules) HTR-PM PRA (2 Reactor Modules)
LWR Case Studies	Seabrook PRA (2 Reactor Units) NRC Level 3 PRA (2 Reactor Units)
Non-LWR Guidance and Standards	ASME/ANS Non-LWR PRA Standard NGNP PRA White Paper [1]
LWR Guidance and Standards	IAEA Technical Approach to MUPSA SR 8.5 [43] IAEA TECDOC 1804 [44] CNSC International Workshop on MUPSA [47]

PRA Technical Adequacy Approach

- Adherence to PRA standards and technical adequacy references
- Peer review focus on PRA aspects different than LWR PRAs
- Integration of PRA into the design and design evaluation process
- Regulatory review of RIPB applications

PRA Technical Adequacy References

- Regulatory Guidance
  - RG 1.200, RG 1.174, RG 1.206
  - SRP Chapter 19
  - NUREG-1860, NUREG-1855
- PRA Standards
  - ASME/ANS PRA Standard for Advanced non-LWRs
  - Supporting LWR PRA Standards
  - IAEA TECDOC 1804, SSG-3, SSG-4, SR-8.5
- UKAEA SAPs

ASME/ANS PRA Standard for Advanced Non-LWRs

- PRA requirements for technical adequacy developed on a reactor technology inclusive basis
  - User defined release categories and event sequence families
  - Supports back end metrics such as QHOs, frequency of dose
  - Does not use LWR metrics such as CDF, LERF or Level 1-2-3 PRA
- Roughly 80% of the requirements are common to LWR PRAs
- Supports full scope, all modes, all hazards PRA similar to LWR Level 3 PRA (sequences developed to dose)
- Supports PRAs done during pre-operational phases
- Supports PRAs on multi-reactor module plants
- Provided input to LWR PRA standard enhancements (drafted for next edition ballot)
  - Mandatory appendix for ALWRs and single unit PRAs on SMRs
  - Non-mandatory appendix for multi-unit PRAs

ASME/ANS PRA Standard for Advanced Non-LWRs

- Issued for 3-yr trial use period December 2013
- Pilot studies being performed for:
  - HTR-PM
  - GE-PRISM
  - Traveling Wave Reactor
  - ANL/KAERI Sodium Cooled Fast Reactor
  - Xe-100 HTGR (PRA in early stage)
  - MCFR (PRA in early stage)
- ANSI standard version to be developed in 2017-2018 timeframe incorporating pilot risk insights:
  - Standard found to be useful to establish technical adequacy
  - More work needs to be done to define risk significance for PRAs with both frequencies and consequences quantified
  - Issue of small numbers

PRA and Applications Peer Review

- Traditional PRA peer review scope to be addressed with more focus on items different than LWR PRAs:
  - Advanced non-LWR reactor fundamentals
  - Definition of safety functions
  - Success criteria bases
  - Selection of initiating events
  - Definition of end states and risk metrics
  - Plant response to events
  - Reactor specific phenomena
  - Data treatment for unique events and components
  - Treatment of uncertainties

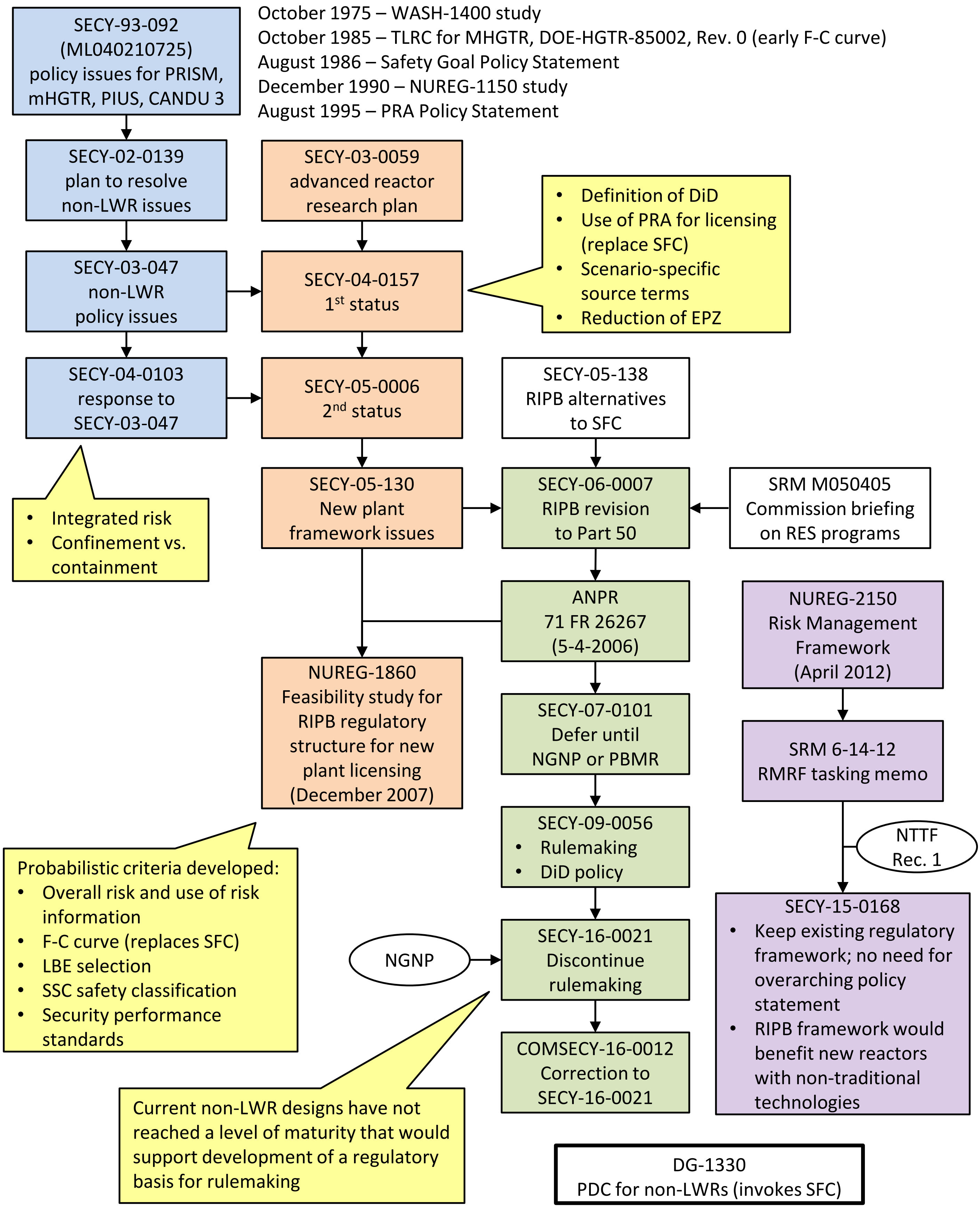
NRC Involvement in ASME/ANS RA-S-1.4-2013

- Active Participation on Writing Group
- NRC review of 2008 Public Review Draft
- No NRC review of 2013 ballot
- Future participation is recommended
  - Ongoing Writing Group participation
  - Review of current trial use standard?
  - Review and endorsement of revised ANSI standard?

QUESTIONS?

Backup Slide to Support Discussions of Licensing Basis Events and Use of Probabilistic Risk Assessment

Non-LWR Licensing Basis
Use of Risk-Informed Performance-Based Approach vs. Single Failure Criterion



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Outline – May 4 morning session

- Introduction
- Planned LMP PRA White Papers
- Functional Containment Performance Criteria
- Public Questions/Comments

Outline – May 4 afternoon session

- Introduction
- NIA White Paper – SDA / Major Portions
- Policy Issues Update – nonLWRs
- Future Agenda Items

Containment

Discussion of Commission Policy Status

Jim Kinsey

Regulatory Affairs Director

Idaho National Laboratory

May 4, 2017

Purpose and Background

This interaction is intended to identify unresolved Commission policy issues associated with advanced reactor designs that address radionuclide retention without reliance on an essentially leak-tight containment structure to protect public health and safety

Clear identification and description of these unresolved issues will promote more efficient industry stakeholder and NRC staff efforts when addressing this key item in NRC's near term Implementation Action Plans

Two areas of Commission policy engagement will be discussed:

1. Is an essentially leak-tight containment structure required?
2. If a structure is not required, what are the performance criteria that apply?

Containment Structure Requirements: Large LWRs

Regulatory requirements pertaining to the containment structure for LWRs are reflected primarily in:

- 10 CFR 50 Appendix A, General Design Criterion 16
- 10 CFR 50 Appendix J

	Design Criteria	Performance Requirements

LWRs	GDC-16: Containment Design
	Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment
		Appendix J to Part 50
		• Type A, B, C tests
		  • Pre-test Requirements
		  • Conduct of Tests
		  • Test Methods
		  • Acceptance Criteria

NRC SECY 93-092: Issues Pertaining to Advanced Reactor Designs

SECY Purpose:

To request Commission guidance for those areas where the staff is proposing to depart from current regulatory requirements in the pre-application review of the advanced reactor and CANDU 3 designs.

SECY addressed a number of areas, including the following three closely related topics:

A) Accident Evaluation

B) Source Term

C) Containment Performance

SECY-93-092: Staff Discussion

The staff recognizes that reactor designs without traditional containment structures or systems represent a significant departure from past practice on LWRs, and that existing LWR containment structures have proved an effective component of our defense-in-depth approach to regulation. However, the Advanced Reactor Policy Statement recognizes that to encourage incorporation of enhanced safety margins (such as in fuel design) in advanced reactor designs, the Commission would look favorably on desirable design-related features or reduced administrative requirements. New reactor designs that deviate from current practice need to be extensively reviewed to ensure that a level of safety at least equivalent to that of current-generation LWRs is provided, and that uncertainties in the design and performance are taken into account.

SECY-93-092 (cont.)

Staff Recommendation: The staff proposes to utilize a standard based upon containment functional performance to evaluate the acceptability of proposed designs rather than-to rely exclusively on prescriptive containment design criteria. The staff intends to approach this by comparing containment performance with the accident evaluation criteria:

- Containment designs must be adequate to meet the onsite and offsite radionuclide release limits for the event categories to be developed…
- For a-period of approximately 24 hours following the onset of core damage, the specified containment challenge event results-in no greater than the limiting containment leak rate used 'in evaluation of the event categories, -and structural stresses are maintained within acceptable limits…. After this period, the containment must prevent uncontrolled releases of radioactivity.

SRM to SECY-93-092:

The Commission approves the staff's recommendations, including the staff's agreement with the ACRS comment.

ARDC Proposal Based On Commission SRM to SECY 93-092

- NRC staff recommendation and Commission feedback resolve the policy question of:
  - Is a leak-tight containment structure required?
- The DOE/lab team developed proposed ARDC 16 content based on this resolution

Technology Type	Design Criteria
LWR	GDC-16: *Containment design.* *Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment*
Adv. Non-LWR	ARDC-16:*Containment design.* *A reactor functional containment, consisting of a structure surrounding the reactor and its cooling system or multiple barriers internal and/or external to the reactor and its cooling system, shall be provided to control the release of radioactivity to the environment and to assure that the functional containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.*

Functional Containment Definition Included with ARDC Proposal

- Functional Containment is defined as: *A barrier, or set of barriers taken together, that effectively limit the physical transport and release of radionuclides to the environment across a full range of normal operating conditions, anticipated operational occurrences, and accident conditions. Functional containment is relied upon to ensure that dose at the site boundary as a consequence of postulated accidents meets regulatory limits.*

- This definition advances a Commission expectation that advanced reactor designs consider incorporating "...defense-in-depth philosophy by maintaining multiple barriers against radiation release..." (NRC's Final Policy Statement on Advanced Reactors, 59 FR 35461).

Performance Requirements

- Performance requirements for LWR containment structures are reflected in 10 CFR 50 Appendix J

- The need for updated performance requirements for advanced non-LWRs that utilize alternatives to an essentially leak-tight containment structure is recognized by industry stakeholders, NRC staff, and the Commission,

- Commission SRM to SECY-03-047 directed the staff to:

  …develop performance requirements and criteria working closely with industry experts (e.g., designers, EPRI, etc.) and other stakeholders regarding options in this area, taking into account such features as core, fuel, and cooling systems design. The staff should pursue the development of functional performance standards and then submit options and recommendations to the Commission on this important policy decision.

NRC Staff Efforts on Performance Requirements (SECY-05-006)

The NRC staff provided recommendations on performance requirements in SECY-05-006, and indicated that:

- The functional performance requirements and criteria for containment in protecting public health and safety vary significantly among new plant designs (e.g., high-temperature gas-cooled, liquid-metal, molten-salt, light-water reactor designs).

- Differences in containment functional performance requirements and criteria reflect differences in the integrated approach that designers use to optimize plant designs to meet risk objectives and safety requirements.

Design Criteria and Perf. Requirements (NRC Staff Feedback: DG-1330)

The NRC staff's reflection of Criterion 16 in DG-1330 indicates that the Commission policy topic addressed and resolved through SECY-93-092 remains unresolved:

**…it is also recognized that characteristics of the coolants, fuels, and containments to be used in non-LWR designs could share common features with SFRs and mHTGRs. Hence, designers may propose using the SFR-DC-16 or mHTGR-DC 16 as appropriate. Use of the mHTGR-DC 16 will be subject to a policy decision by the Commission."*

Technology Type	Design Criteria	Performance Requirements
LWR	GDC-16: *Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment*	Appendix J to Part 50 • Type A, B, C tests • Pre-test Requirements • Conduct of Tests • Test Methods • Acceptance Criteria
Adv. Non-LWR	Same as GDC*	To be developed

Industry's Understanding of Commission Policy Issue Status

- Is a leak-tight containment structure required?
  - Resolved - Not required per SRM to SECY-93-092
- If a structure is not required, what are the performance criteria that apply?
  - Not yet resolved
  - Suggested area of industry and NRC focus per near term IAP

Technology Type	Design Criteria	Performance Requirements

LWR	GDC-16:
	Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment
		Appendix J to Part 50
		• Type A, B, C tests
		  • Pre-test Requirements
		  • Conduct of Tests
		  • Test Methods
		  • Acceptance Criteria

Adv. Non-LWR	ARDC-16 (proposed) **Policy Resolved**	TBD – open Commission policy topic

Status of Containment Policy Topic(s)

- Industry believes that the Commission policy question of whether an essentially leak-tight containment structure is required for advanced non-LWRs has been resolved

- Industry recognizes the need for further engagement with the NRC staff in establishing functional performance requirements for the various advanced non-LWR technology types, building on prior efforts in this area
  - NRC Near Term IAP - policy issue – proposed area of focus

Next Steps

- Confirm that Commission policy provides for advanced non-LWR designs to utilize a functional containment approach, rather than requiring an essentially leak-tight containment structure
  - If not confirmed, identify remaining open Commission policy question(s), in consideration of the SRM to SECY 93-092

- Pursue the establishment of functional containment performance requirements for advanced non-LWRs
  - Identify how these requirements or criteria should be included in regulatory documentation (e.g. RG, SRP) for use by non-LWR license applicants

SECY 05-006

SECY-05-006, “Second Status Paper on the Staff's Proposed Regulatory Structure for New Plant Licensing and Update on Policy Issues Related to New Plant Licensing”

- This SECY is a policy issue information paper that describes the staff’s work on several issues that were considered in the development of a future technology-neutral framework for reactor licensing, including the Commission-requested efforts on containment functional performance.

SECY 05-006 Position on Containment Functional Performance in Non-LWRs

The staff has concluded that the function of containment has a direct or supporting role in the following accident prevention and mitigation safety functions:

- *Protecting risk-significant SSCs from internal and external events*
- *Physically supporting risk-significant SSCs*
- *Protecting onsite workers from radiation*
- *Removing heat to prevent risk-significant SSCs from exceeding design or safety limits*
- *Providing physical protection (i.e., security) for risk-significant SSCs*
- *Reducing radionuclide releases to the environs and limiting core damage*

Modular HTGR Example (NGNP assessment)

In addition to the SECY 05-006 list of functional performance attributes;

The upper tier performance standard for the functional containment for the NGNP should be to ensure the integrity of the fuel particle barriers … rather than to allow significant fuel particle failures and then need to rely extensively on other mechanistic barriers (e.g., the helium pressure boundary and the reactor building). This standard should be characterized by [the following]:

- *[Ensuring] radionuclide retention within fuel during normal operation with relatively low inventory released into the helium pressure boundary (HPB).*

- *Limiting radionuclide releases to the environs to meet the onsite and offsite radionuclide dose acceptance criteria (i.e., 10 CFR 50.34 and EPA PAGs) at the EAB with margin for a wide spectrum of off-normal event sequences.*

- *Maintaining the capability to establish controlled leakage and controlled release of delayed accident source term radionuclides.*

NUCLEAR INNOVATION ALLIANCE

"Major Portions" Project (Standard Design Approval)

May 04, 2017

Background

- 10 CFR Part 52, Subpart E allows an applicant to seek standard design approval for either an entire plant or “major portions” thereof
- NIA clarifying the meaning of “major portions” to make SDA process useful for advanced reactor developers
- Phase 1 report reviewed by industry (e.g., NEI/ARWG) and posted on NIA website at

www.nuclearinnovationalliance.org

NUCLEAR INNOVATION ALLIANCE

Purpose/Benefit of SDA

- From NRC's *Regulatory Review Roadmap*:
  - Useful tool in combination with preapplication interactions during conceptual/preliminary design
  - Documents staff findings, involves ACRS reviews, provides reference for subsequent applications
  - Incremental progress towards licensing or certification as part of staged licensing
- Licensing risk reduction (via approval of limited portion of design
- Reduce initial development cost (defer portions to subsequent licensing steps)
- Approval for portion as part of commercial strategy, e.g.:
  - In support of future CPA
  - Deployment outside US
  - Deployment for demonstration purposes

NUCLEAR INNOVATION ALLIANCE

Scope of “Major Portions” - Examples

- Significant portion of safety basis with significant functional safety requirements
- More limited portion of design (and safety basis) = more limited approval and different set of boundary conditions – e.g., set of SSCs with high regulatory risk that influences business case for development
- Site-related parameter such as ground motion response spectra and certain aspects of structural design to ensure early NRC concurrence on novel techniques
- Novel systems not traditionally captured within scope of safety-related SSCs, e.g., molten salt processing systems, waste or new fuel processing, or security SSCs

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Considerations

- Is it the same or almost as much work as full application (CP/DC)?
- Could one or more Topical Reports accomplish the same?
- Programmatic risk of issues not resolved as part of SDA?
- Sufficient information to support SER?
- Risk reduction/timing advantages compatible with development needs?
- Will this result in additional overall cost of review?

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Next Steps

- Q&A today
- Feedback factored into Phase 2 report

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Thank you

Feedback & Questions

Please feel welcome to send additional input at any time to Ashley Finan (ashley@nuclearinnovationalliance.org).

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Policy Issues Update
non-LWRs

May 4, 2017

Public Meeting

- Telephone Bridge

  (888) 793-9929

  Passcode: 2985270
- Opportunities for public comments and questions at designated times

Policy Issues Update

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
Issues with Ongoing Activities for non-LWRs		
License for Prototype Reactors	NRC staff drafting white paper	White paper to be issued in near future and discussed in periodic stakeholder meetings
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 (e.g., FRN on siting in close proximity to populations to be issued in near future)
Offsite Emergency Planning (EP) Requirements	SECY-15-0077 Drafting Regulatory Basis	Draft Regulatory Basis issued for public comment (NRC-2015-0225)
Insurance and Liability	Evaluating for periodic report to Congress on Price-Anderson Act	Plans to discuss in future periodic stakeholder meetings (Fall 2017) and prepare input for Commission paper (2019)
Use of Probabilistic Risk Assessment in the Licensing Process	SRP Revisions (safety focused review)	This topic is related to LMP and future white papers/guidance
Implementation of Defense-In-Depth (DiD) Philosophy for Advanced Reactors	SECY-15-0168 (part of licensing framework)	This topic is related to LMP and future white papers/guidance
Security and Safeguards Requirements for SMRs	NEI White Paper	Current topic of interactions between NRC staff and stakeholders in context of NEI white paper and possibly related to NRC security design considerations issued for public comment (NRC-2017-0073)
Licensing Basis Event Selection	Ongoing discussions	This topic is related to LMP and submitted white paper (ML17104A254)
Fuel qualification, materials qualification	Issues vary by fuel type and reactor technology	Ongoing discussions with advanced reactor technology groups and developers
Increased enrichments	Ongoing discussions	Awaiting white paper(s) from NEI/NIC

Policy Issues Update

Issues with Ongoing Activities for non-LWRs

Policy Issues Update

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
Open Issues for non-LWRs but no current activities		
Annual Fees	Final Rule (May 2016) - Annual fees scalable based on licensed thermal power rating, applicable only to LWR SMRs	Part 171 definitions: Small modular reactor (SMR) for the purposes of calculating fees, means the class of light-water power reactors 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)
Key Component and System Design Issues	Design Specific	(potentially related to LMP and future white paper on SSC safety classification)
Fuel cycle facilities (front end)	Ongoing discussions	Generally deferred to NRC mid-term IAP activities pending specific needs/timeline for technology or design-specific licensing and deployment.
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.

Policy Issues Update

Open Issues for non-LWRs but no current activities

Policy Issues Update

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
Issues with no current plans to undertake activities (resolved or need input from stakeholders)		
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

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Policy Issues Update

Issues with no current plans to undertake activities
(resolved or need input from stakeholders)

Advanced Reactor Program