



# Advisory Committee on Reactor Safeguards (ACRS)

**10 CFR Part 53 “Licensing and Regulation  
of Advanced Nuclear Reactors”**

**November 2, 2022**

# Agenda

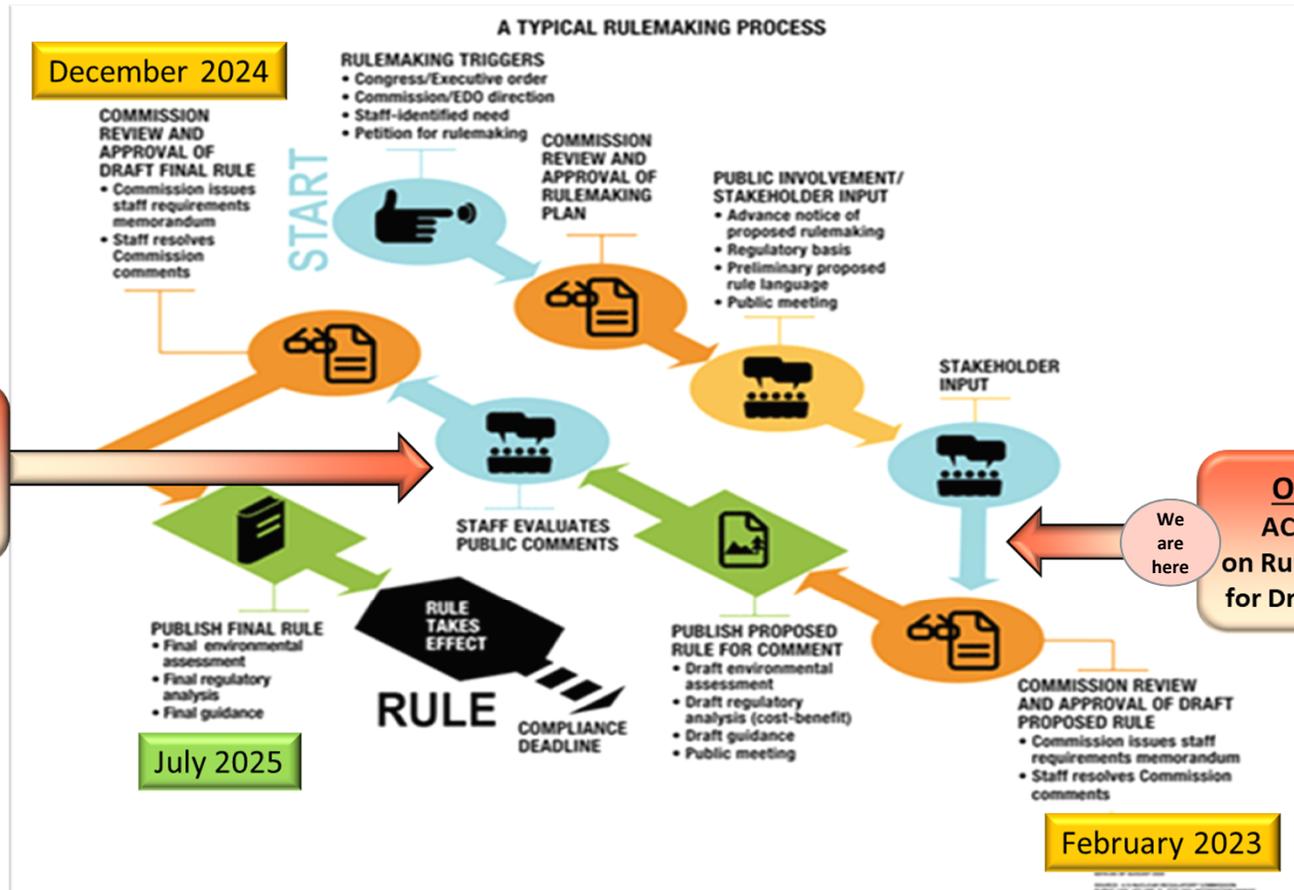


**8:35 am – 10:30 am**

Staff presentation on 10 CFR Part 53, “Risk-Informed, Technology-Inclusive Regulatory Framework for Commercial Nuclear Plants,” Proposed Rulemaking Language

- Rulemaking Schedule
- Part 53 Licensing Frameworks
- Risk Insights/Quantitative Health Objectives (QHOs)
- Fueled Modules
- Codes and Standards
- Alternative evaluation for risk insights (AERI)
- Generally licensed reactor operators (GLROs), Human Factors, Engineering Expertise
- Guidance

# Rulemaking Schedule



# Part 53 Licensing Frameworks

Subpart A - General Provisions

**Rule Package  
(ML22272A034)**

Subpart B - Safety Requirements  
Subpart C - Design Requirements  
Subpart D - Siting  
Subpart E - Construction/Manufacturing  
Subpart F - Operations  
Subpart G - Decommissioning  
Subpart H - Application Requirements  
Subpart I - License Maintenance  
Subpart J - Reporting  
Subpart K - Quality Assurance

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Subpart S - License Maintenance  
Subpart T - Reporting  
Subpart U - Quality Assurance

## Framework A

- Probabilistic Risk Assessment (PRA)-led approach
- Functional design criteria

## Framework B

- Traditional use of risk insights
- Principal design criteria
- Includes an AERI approach

Sections  
53.000  
and  
53.010

- Purpose
  - Provide optional frameworks for the issuance, amendment, renewal, and termination of licenses, permits, certifications, and approvals for commercial nuclear plants
- Frameworks
  - Framework A and Framework B are distinct
  - Applicants and licensees subject to the rules in this part must only use the subparts applicable to one framework

# Subpart A – General Provisions (Definitions)

- Common Definitions
  - Commercial Nuclear Plant
  - Manufactured reactor
  - Manufactured reactor module
  - ***Safety function***
- Framework A Definitions
  - Construction, Licensing basis events (LBEs), structure, system, and component (SSC) classifications
- Framework B Definitions
  - Construction, Design basis, Functional containment, Safety-related SSCs, Severe nuclear accident

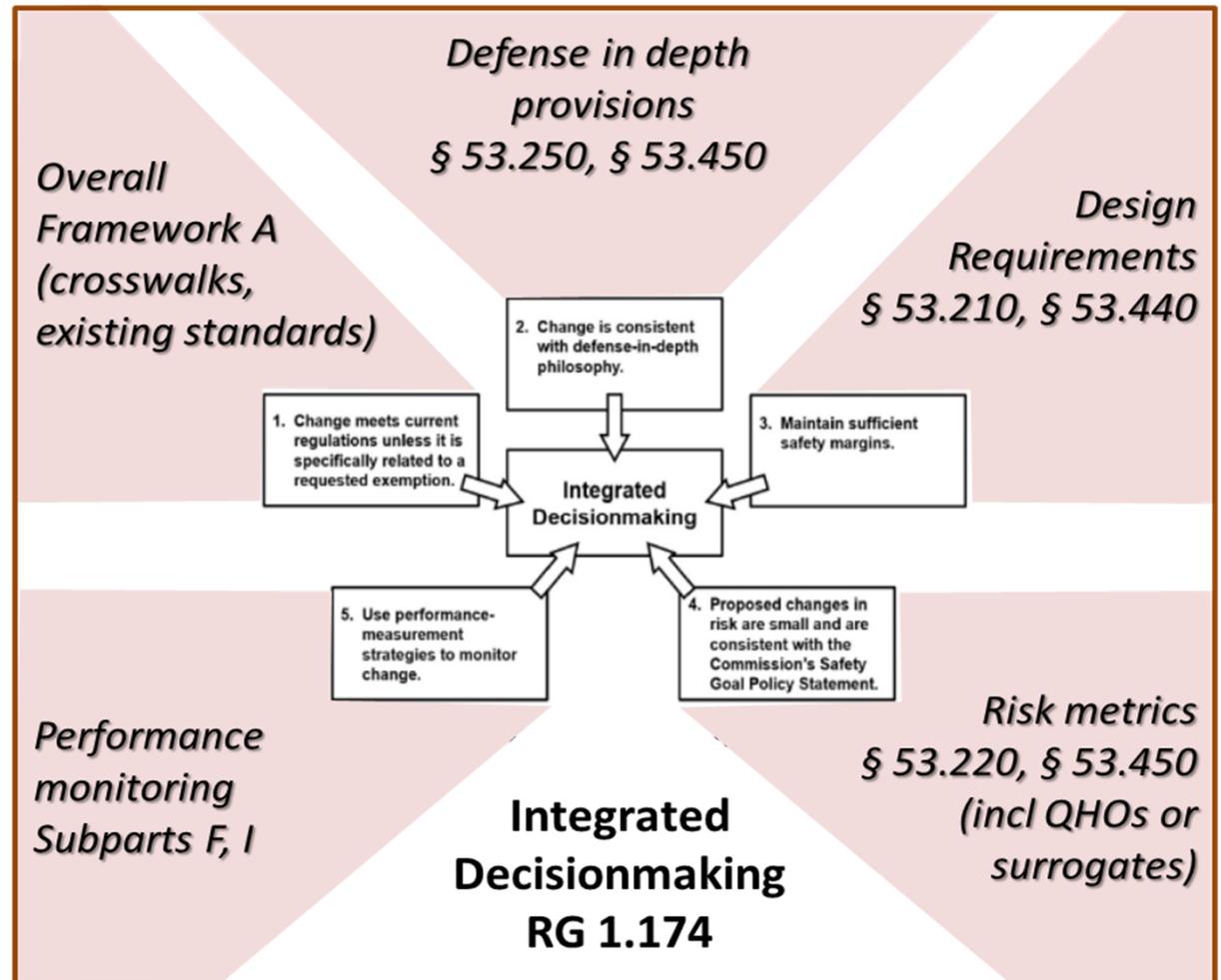
## Framework A

<i>Subpart</i>	<i>Title</i>	<i>Topics</i>
Subpart B	Technology-Inclusive Safety Requirements	Risk Insights (QHOs)
Subpart C	Design and Analysis Requirements	
Subpart D	Siting Requirements	
Subpart E	Construction and Manufacturing Requirements	Fueled Modules
Subpart F	Requirements for Operation	GLROs, Human Factors
Subpart G	Decommissioning Requirements	
Subpart H	Licenses, Certifications and Approvals	
Subpart I	Maintaining and Revising Licensing Basis Information	
Subpart J	Reporting and Other Administrative Requirements	
Subpart K	Quality Assurance Criteria for Commercial Nuclear Plants	

## Framework A

Ensuring  
Comparable  
Level of Safety

Additional discussion in Preamble on how an integrated assessment like that in Regulatory Guide (RG) 1.174 can be used to support the comparisons to existing requirements and related regulatory findings.



## Framework A

QHOs as one of several performance standards for LBEs

Additional discussion in Preamble on how QHOs are considered as one of several performance measures within Framework A. **Including the QHOs as one of several performance measures does not equate to the QHOs defining adequate protection of public health and safety.\***

### \*Existing Paradigm

- Does not specifically define “adequate protection” but compliance with NRC regulations and guidance may be presumed to assure adequate protection at a minimum
- Additional requirements as necessary or desirable to protect health or to minimize danger to life or property

### Safety Objectives & Criteria

No immediate threat & consider potential risks

§ 53.210 Safety criteria for DBAs

§ 53.220 Safety criteria for other LBEs

➤ Address LBEs and provide defense in depth

➤ Cumulative risks (QHOs)

§ 53.450(e) Evaluation criteria for each LBE or event category

### Example § 53.450(e) evaluation criteria

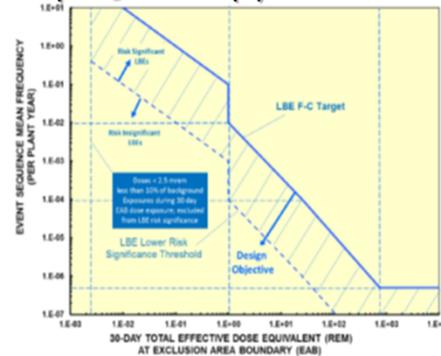
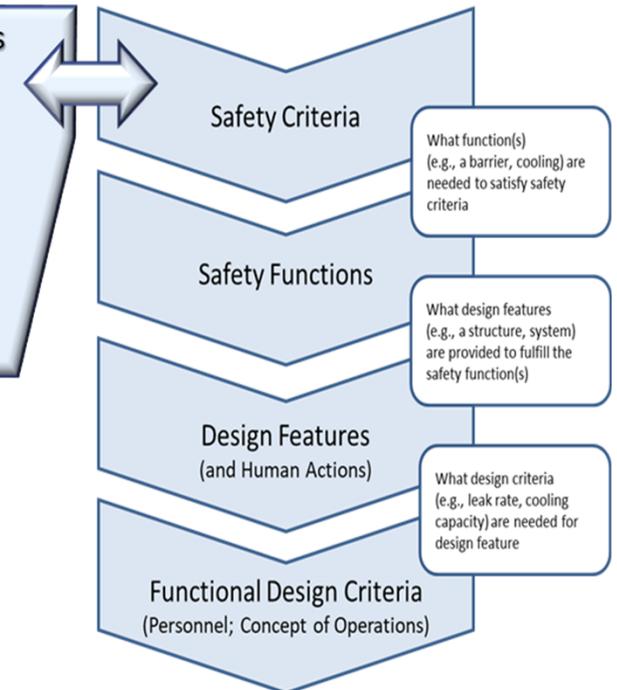


Figure 3-4. Use of the F-C Target to Define Risk-Significant LBEs  
Licensing Modernization Project (LMP)



## Subparts E & O

### Fuel loading for manufactured reactor modules

#### § 53.620(d) / § 53.4120(d) Fuel loading

- A manufacturing license may include authorizing the loading of fuel into a manufactured reactor module
- Specify required protections to prevent criticality
  - At least two independent mechanisms that can prevent criticality should conditions result in the maximum reactivity being attained for the fissile material
- Commission finding that a manufactured reactor module in required configuration is not a utilization facility as defined in the Atomic Energy Act
- Manufactured reactor module becomes a utilization facility in its final place of use after the Commission makes required findings on inspections, tests, analyses and acceptance criteria

<b>Framework B</b>		
<i>Subpart</i>	<i>Title</i>	<i>Topics</i>
Subpart N	Siting	
Subpart O	Construction and Manufacturing Requirements	
Subpart P	Requirements for Operation	Codes and Standards
Subpart Q	Decommissioning	
Subpart R	Licenses, Certifications and Approvals	Codes and Standards AERI
Subpart S	Maintaining and Revising Licensing Basis Information	
Subpart T	Reporting and Other Administrative Requirements	
Subpart U	Quality Assurance	

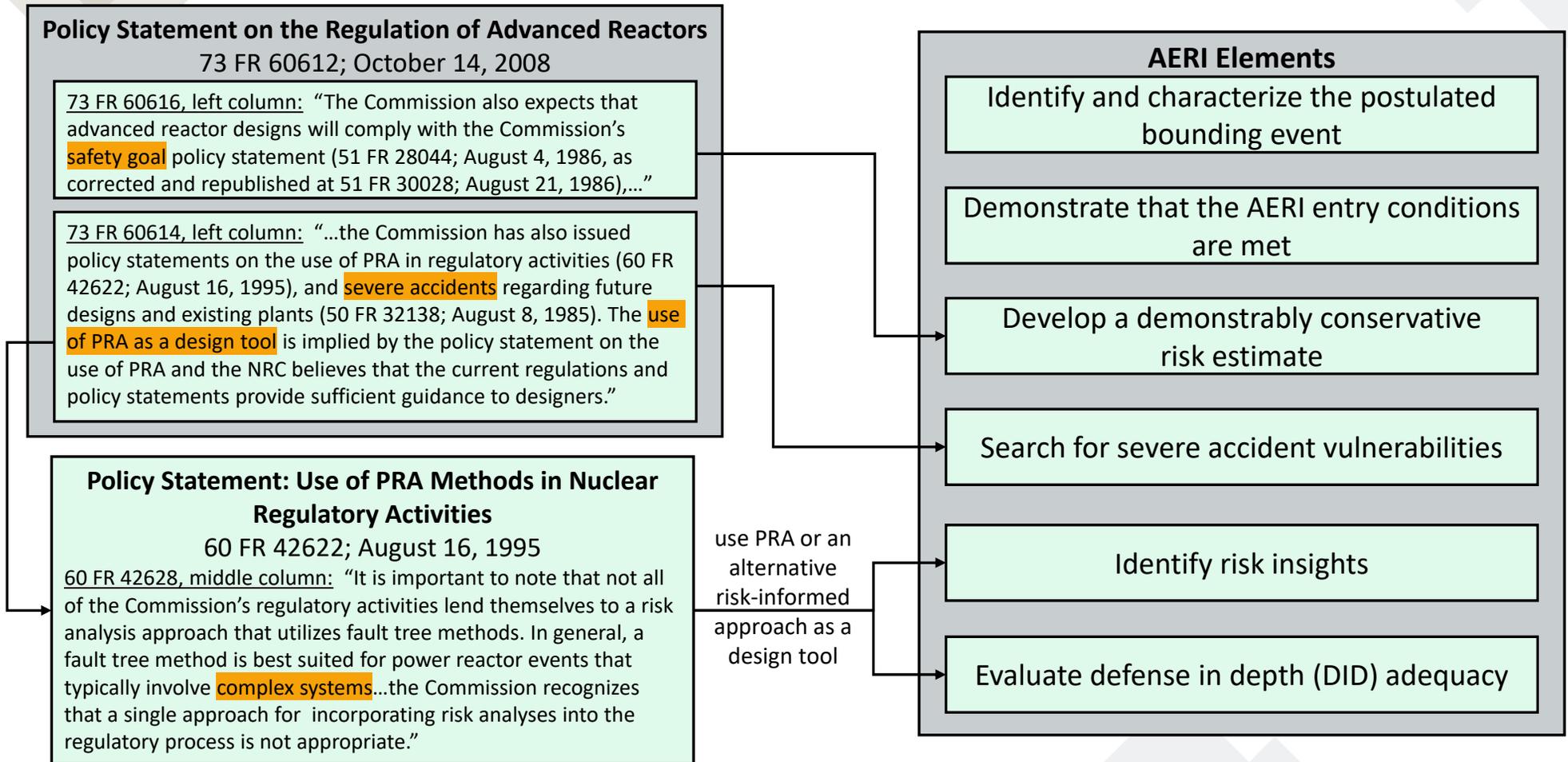
## Codes and Standards (Clarification)

- **10 CFR 53.4730(a)(2)(ii)(A) would require applicants to provide a description and justification (for codes or standards not previously endorsed or accepted by the NRC) of the codes and standards to be used in the design**
- **Other Framework B requirements related to codes and standards are similar to those in the existing regulations**
  - **10 CFR 53.4360(a) would require boiling-water reactor (BWR) and pressurized-water reactor (PWR) licensees to meet requirements in 10 CFR 50.55a for inservice inspection and inservice testing programs**
  - **10 CFR 53.4730(a)(37)(ii) would require applicants for BWRs and PWRs to describe how they will comply with ASME Boiler and Pressure Vessel Code and ASME Operation and Maintenance Code requirements in 10 CFR 50.55a**
  - **Conforming changes proposed for 10 CFR 50.55a would support use of existing requirements by applicants and licensees with BWRs or PWRs under Framework B**

## Subpart R – AERI

- **The AERI approach is consistent with Commission policy.**
- **The AERI entry conditions in § 53.4730(a)(34)(ii) were revised after the ACRS Part 53 subcommittee meeting (October 18-19, 2022) to address stakeholder comments and reflect insights from the scoping MELCOR Accident Consequence Calculation System (MACCS) calculations.**
- **Other provisions in Part 53 reference make use of the AERI entry conditions.**
- **Two draft regulatory guides (DGs) developed:**
  - **DG-1413: Technology-Inclusive Identification of Licensing Events for Commercial Nuclear Plants (proposed new RG 1.254)**
  - **DG-1414: Alternative Evaluation for Risk Insights Methodology (proposed new RG 1.255)**

# Regulatory Basis for the AERI Approach



## Why Revise the AERI Entry Conditions?

- Some stakeholders have commented that the current proposed AERI entry conditions are overly conservative.
- MACCS scoping calculations indicate that dose at 100 meters is an inadequate predictor of conditional risk. Depending on the assumptions (e.g., plume elevation or buoyancy), some conditional risks may be below the QHOs while others may be above the QHOs even though the current AERI entry condition is met.
- Provide increased flexibility when determining if the AERI entry conditions are met.

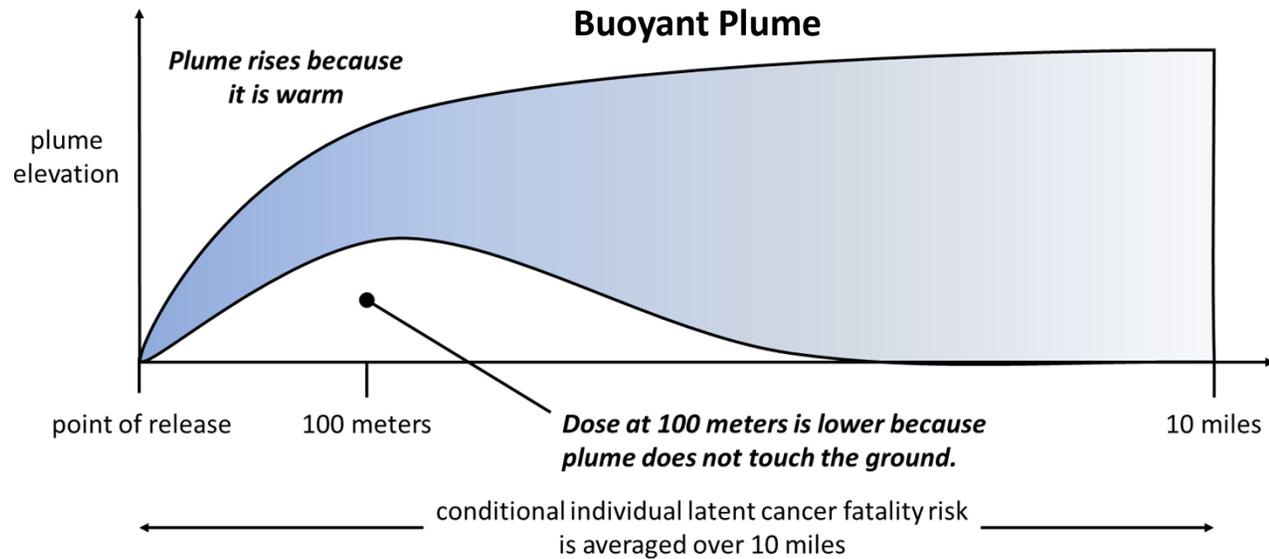
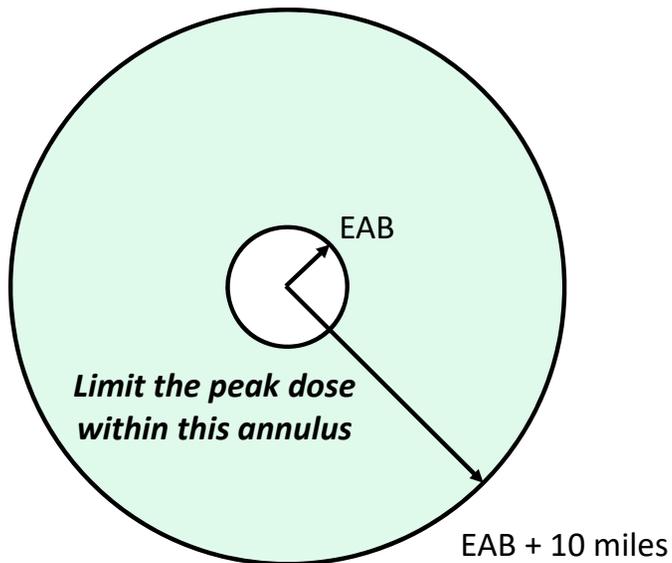
# Revised AERI Entry Conditions

§ 53.4730(a)(34) *Description of risk evaluation.* A description of the risk evaluation developed for the commercial nuclear plant and its results. The risk evaluation must be based on:

- i. A probabilistic risk assessment (PRA); or
- ii. An alternative evaluation for risk insights (AERI), provided that:
  - (A) The analysis of a postulated bounding event demonstrates that the consequence evaluated within the area between the commercial nuclear plant's exclusion area boundary (EAB) and 16.1 kilometers (10 miles) from the EAB is less than 25 mSv (2.5 rem) TEDE in the first year; and
  - (B) The identification of the postulated bounding event is informed by a systematic and comprehensive search for severe nuclear accident scenarios that considers:
    - (1) All radiological sources at the commercial nuclear plant;
    - (2) Relevant internal and external hazards;
    - (3) Combinations of plant equipment failures including common-cause failures, hazard-induced equipment failures, and equipment failures caused by severe nuclear accident phenomena; and
    - (4) Credible human errors of commission and omission.

# Rationale for the Revised AERI Entry Conditions

- The change from dose at 100 meters to the peak dose within the 10-mile annulus addresses concerns about elevated releases and plume buoyancy.



## Rationale for the Revised AERI Entry Conditions (Con't.)

- The 2.5-rem criterion is consistent with MACCS scoping calculations:
  - A 25-rem lifetime (50-year) dose generally corresponds to a 10-mile population-weighted lifetime individual latent cancer fatality risk less than  $2E-6$  per event.
  - A first-year dose of 2.5 rem generally corresponds to a 50-year dose less than 25 rem, probably due to radioactive decay and the effect of weathering on groundshine and resuspension.
- The 2.5-rem criterion is a small fraction (10%) of the traditional reference value (25 rem) used in Part 100 and § 50.34.
  - For example, see the Standard Review Plan (NUREG-0800), Section 15.0.3, Rev. 0: “A small fraction is defined as less than 10% of the 10 CFR 50.34(a)(1) reference values, or 2.5 rem TEDE.”

# Proposed Uses of the AERI Entry Conditions

- Would be used to determine:
  - Which applicants could develop an AERI in lieu of a PRA to demonstrate compliance with the proposed risk evaluation requirement in § 53.4730(a)(34)
  - When the requirements to address the mitigation of beyond-design-basis events in § 53.4420 must be met
  - When the requirements to address combustible gas control in § 53.4730(a)(7) must be met
- In addition, the proposed AERI entry conditions would be used in combination with other conditions to determine when a commercial nuclear plant is a self-reliant mitigation facility, as provided in § 53.800(a)(2)
  - A self-reliant mitigation facility must have GLROs in lieu of senior reactor operators and reactor operators
    - **All other applicable Framework B requirements must be met (AERI or PRA).**
    - **Applicants may elect to develop a PRA even if the AERI entry conditions are met.**

# DG-1413: Technology-Inclusive Identification of Licensing Events for Commercial Nuclear Plants (proposed new RG 1.254)

- Section A: Applies to light-water reactors (LWRs) and non-LWRs licensed under Parts 50, 52, and 53 (Frameworks A and B)
- Section B (Discussion):
  - Identifies licensing events for each licensing framework
  - Provides historical perspectives (early licensing, development of the standard review plan)
  - Addresses ACRS recommendations to “start with a blank sheet of paper” (10/7/2019, 10/21/2020, 5/30/2021, and 10/26/2021)
- Section C (Staff Guidance) provides an integrated approach for:
  - Conducting a systematic and comprehensive search for initiating events
  - Delineating a systematic and comprehensive sets of event sequences
  - Grouping the lists of initiating events and event sequences into licensing events
- Appendix A (Comprehensive Search for Initiating Events):
  - Reviews techniques for searching for initiating events and points the user to helpful references
  - Does not endorse or recommend any specific technique

# DG-1414: Alternative Evaluation for Risk Insights Methodology (proposed new RG 1.255)

- This RG provides the NRC staff's guidance on the use of an AERI methodology to inform the content of applications and licensing basis for LWRs and non-LWRs.
- 10 CFR 53.4730(a)(34)(ii) establishes AERI as an alternative to a PRA for a risk evaluation if the entry conditions A and B for an AERI are met.
- The title of this DG-1414 is now "AERI Methodology," to distinguish it from Part 53 Frameworks A and B. This new title does not signal any change in approach.

Applicants who meet the AERI entry conditions may elect to develop an AERI in lieu of a PRA.

However, PRA confers additional benefits such as:

- A means to optimize the design, and
- The ability to take advantage of various risk-informed initiatives, for example risk-informed completion times, risk-informed categorization of SSCs.

## Subparts F and P Staffing, HFE, Operator Licensing, and Training

- During the 10/19/22 subcommittee meeting, the staff provided an update on the rule language, as well an overview of key guidance
- Updates on the rule language status had included:
  - Consolidating Frameworks A & B requirements using a common set of language under Subpart F
  - Extending provisions for GLROs to Framework B, to include facilities using an AERI approach
  - Retaining previous engineering expertise provisions (i.e., degreed individuals with plant familiarity)
- Important points of ISG presentations included:
  - Review guidance for tailored exam programs
  - Staffing review guidance for custom staffing plans
  - Guidance for conducting scalable human factors engineering (HFE) reviews

# Follow-on Discussion of Operator Licensing Topics

- Regarding Operator Licensing, the members asked that the staff discuss several areas further, including:
  - Lack of approval preceding licensing of GLROs
    - NRC approved program with inspections
  - How changes to operator tasks from plant mods translate into adjustments to exam program knowledge and abilities lists and change control process burdens
    - Balances adaptability and program assurance
  - How the GLRO criteria interrelate with the AERI criteria and whether AERI is too restrictive
    - The following slide provides an overview that builds on earlier AERI discussions...

# Follow-on Discussion of GLRO Criteria

Underlying Principle from Paper	GLRO Criteria for Framework A	GLRO Criteria for Framework B (PRA)	GLRO Criteria for Framework B (AERI)
Radiological consequence criteria met without human action	Safety criteria (53.210 and 53.220 or 53.470) met without human actions for credited event mitigation	Safety assessment (53.4730(a)(1)(vi)) demonstrates requirements met without credited human action	Qualification for AERI (53.4730(a)(34)(ii)) must be demonstrated to be met
Licensing basis events addressed without human action	Analysis of LBEs and DBAs (53.450(e & f)) demonstrates criteria met without human actions for credited mitigation	PRA (53.4730(a)(34)) demonstrates event sequences met without human actions for credited mitigation	
Safety functions not allocated to human action	Safety functions (53.230) achieved without reliance on human actions for credited event mitigation	FRA/FA (53.730(d)) demonstrates functions required for safety do not rely on credited human action	
Reliance on inherent or robust passive features	Plant response to licensing basis events does not credibly rely on human actions to assure the performance of SSCs (e.g., SSCs function through inherent characteristics or have engineered protections against human failures)		
Adequate DID without human action	DID requirements (53.250) met without human actions for the purposes of credited DID	Plant design must provide for layered DID without dependence upon any single barrier or reliance upon credited human action.	

## Follow-on Discussion of Staffing Topics

- Regarding operational staffing, the members asked that the staff discuss several areas further, including:
  - Potential for allowing plants with no operators
    - There is no allowance for zero operator staffing
  - Engineering expertise degree requirement
    - Complements/augments plant ops experience
  - Training requirements for engineering expertise role
    - Systems approach to training required by § 53.830; topics covered by ISG
  - Availability of remote engineering expertise
    - Not credited in event mitigation; supports crew
  - Requirements might allow remote operation
    - Framework for staffing, HFE, operator licensing, and training is designed to adapt to future concept of operations; remote operations is a broader issue

# Key Guidance Development

## Under Development

### Existing

- LMP (RG 1.233)
- Siting Criteria (RG 4.7)
- Fuel Qualification Framework (NUREG-2246)
- Developing Principal Design Criteria for Non-LWR (RG 1.232)

### Near-Term

- TICAP (NEI 21-07) / ARCAP ISGs
- ASME/ANS Non-LWR PRA Standard
- Non-LWR PRA Standard Applicability ISG
- High Temp Materials (ASME III-5)
- Reliability & Integrity Mgt (ASME XI-2)
- Molten Salt Reactor Fuel Qualification
- Seismic Design / Isolators
- Emergency Planning (50.160)
- Change Evaluation (SNC-led)
- QA Alternatives (NEI-led)
- Facility Training Programs ISG
- Materials Compatibility ISG
- Treatment of Consequence Uncertainty

### Part 53

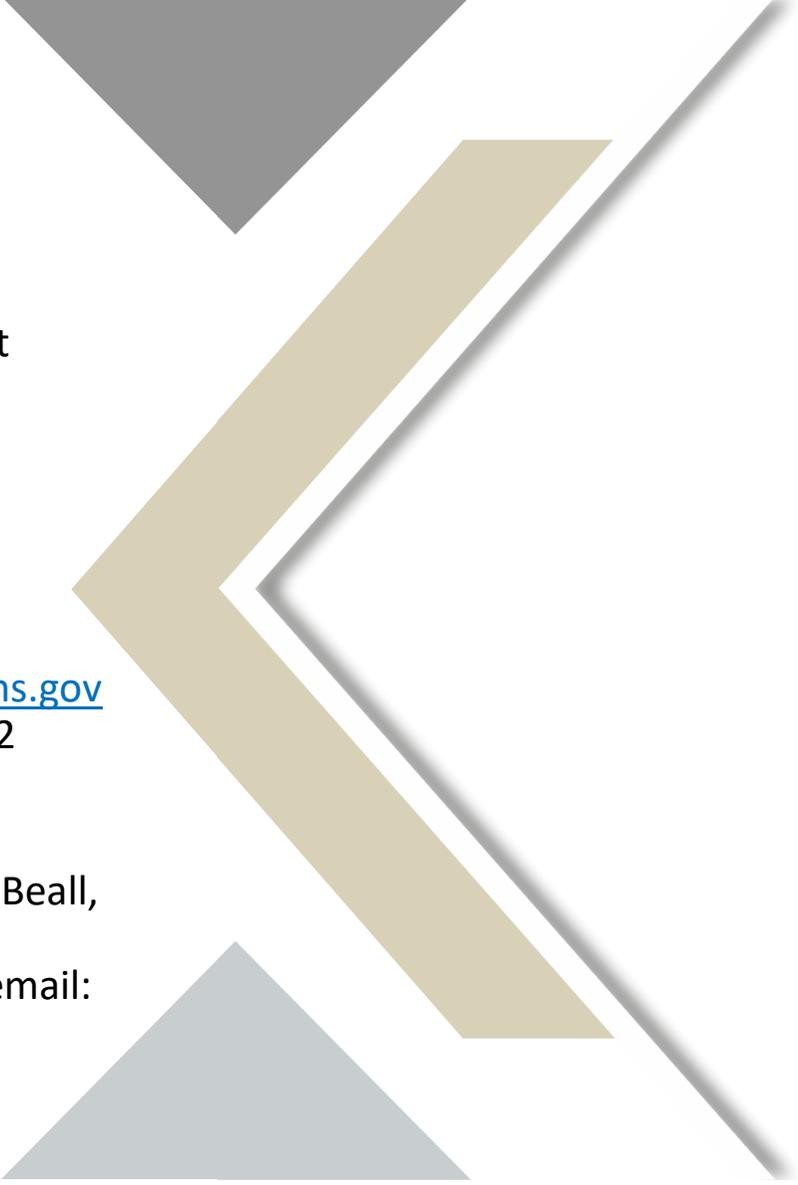
- *DG-1413, Identification of Licensing Events*
- *DG-1414, AERI Methodology*
- *DRO-ISG-2023-01, Operator Licensing Program Review ISG*
- *DRO-ISG-2023-02, Staffing Plan Review ISG Augmenting NUREG-1791*
- *DRO-ISG-2023-03, Scalable Human Factors Engineering Review ISG*
- Part 26, Fitness for Duty
- Part 26, Fatigue Management
- Part 73, Access Authorization
- Part 73, Cyber Security

### Future

- Analytical Margin
- Chemical Hazards
- Manufacturing
- Technical Specifications
- Facility Safety Program
- Framework B Content of Applications

# Discussion

## Additional Information



Additional information on the 10 CFR Part 53 rulemaking is available at <https://www.nrc.gov/reactors/new-reactors/advanced/rulemaking-and-guidance/part-53.html>

For information on how to submit comments go to <https://www.regulations.gov> and search for Docket ID NRC-2019-0062

For further information, contact Robert Beall, Office of Nuclear Material Safety and Safeguards, telephone: 301-415-3874; email: [Robert.Beall@nrc.gov](mailto:Robert.Beall@nrc.gov)

# Acronyms

ACRS	Advisory Committee on Reactor Safeguards	EDO	Executive Director for Operations
AERI	Alternative evaluation for risk insights	FA	function allocation
ANS	American Nuclear Society	FR	<i>Federal Register</i>
ARCAP	Advanced Reactor Content of Application Project	FRA	functional requirements analysis
ASME	American Society of Mechanical Engineers	GLRO	generally licensed reactor operator
BWR	boiling-water reactor	HFE	human factors engineering
CFR	Code of Federal Regulations	ISG	interim staff guidance
DBA	design-basis accident	LBE	licensing basis events
DG	draft regulatory guidance	LMP	Licensing Modernization Project
DID	defense-in-depth	LWR	light-water reactor
DRO	Division of Reactor Oversight		MELCOR accident consequence code system
EAB	exclusion area boundary	MACCS	
		mSv	millisievert

# Acronyms

NEI	Nuclear Energy Institute	QHO	quantitative health objective
non-LWR	non-light-water reactor	rem	Roentgen equivalent man
NRC	U.S. Nuclear Regulatory Commission	RG	regulatory guide
	U.S. Nuclear Regulatory Commission	SNC	Southern Nuclear Operating Company
NUREG	technical report designation	SSCs	structures, systems, and components
PRA	probabilistic risk assessment	TEDE	total effective dose equivalent
PWR	pressurized-water reactor		Technology Inclusive Content of
QA	quality assurance	TICAP	Application Project