Part 53 Framework B Overview

Public Meeting
6/16/22

Agenda

- Overview of Part 53 Structure
- Comparison of Part 53 Frameworks
- Framework B Development Approach
- Framework B Subparts Overview
- Alternative Evaluation of Risk Insights (AERI)
- Next steps

Welcome and Introductions

Welcome:
Rob Taylor, Office of Nuclear Reactor Regulation

NRC Speakers / Presenters:
Office of Nuclear Material Safety and Safeguards

- Bob Beall

Office of Nuclear Reactor Regulation

- Bill Jessup
- Marty Stutzke
- Charles Moulton
- Boyce Travis

Meeting Slides:
ADAMS Accession No. ML22165A114

Purpose of Today's Meeting

- Overview of the Part 53 proposed Framework B rulemaking effort.
- Today's meeting is a "Comment-Gathering" meeting, which means that public participation is actively sought in the discussion of the regulatory issues during the meeting.
- The meeting is being transcribed and the transcription will be available with the meeting summary by July 16, 2022.
- No regulatory decisions will be made at today's meeting.

Part 53 Licensing Frameworks

Subpart A - General Provisions

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

Framework A

- Probabilistic risk assessment (PRA)-led approach
- Functional design criteria

Subpart N - Definitions
Subpart O - Construction/Manufacturing
Subpart P - Operations
Subpart Q - Decommissioning
Subpart R - Application Requirements
Subpart S - License Maintenance
Subpart T - Reporting
Subpart U - Quality Assurance

Framework B

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

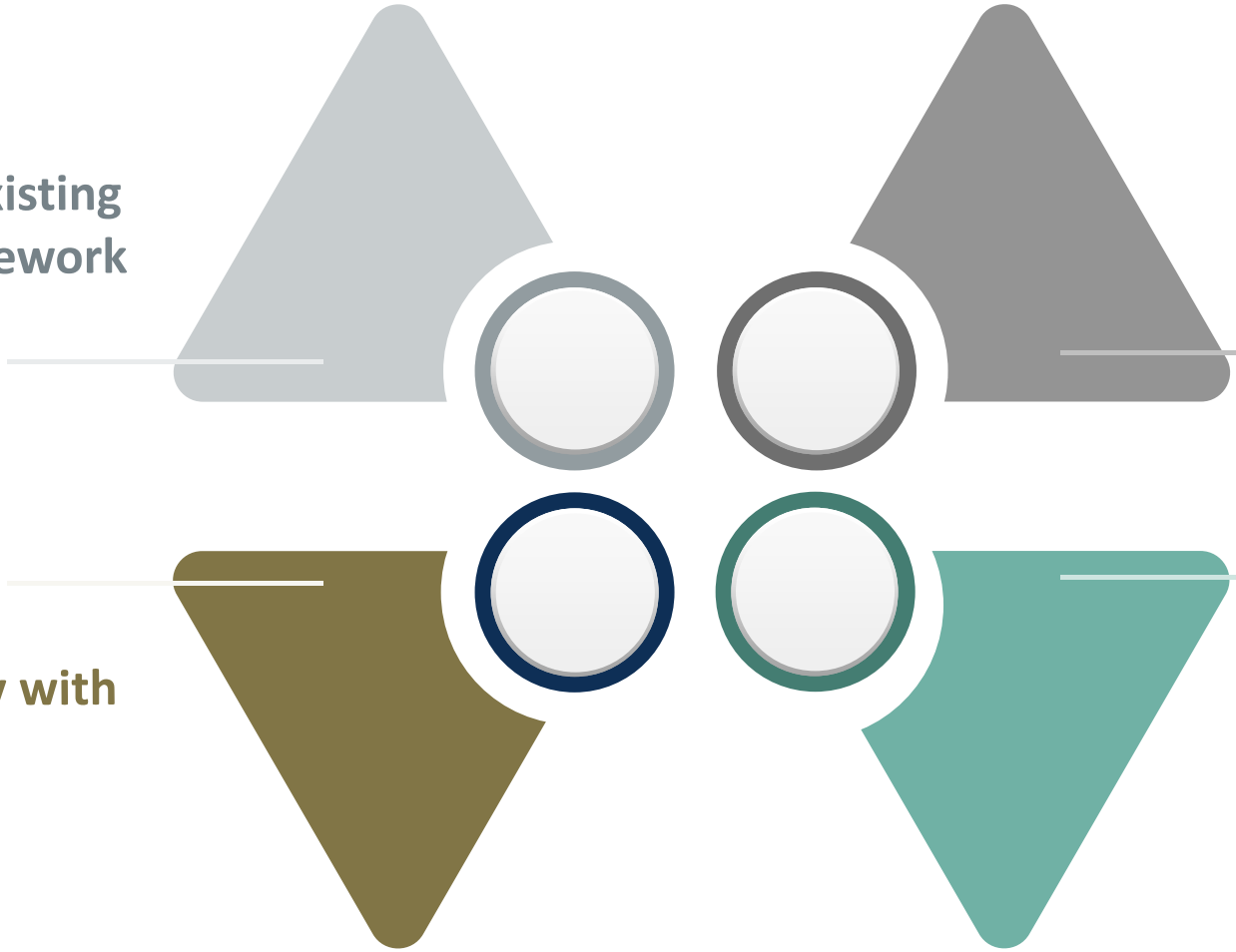
Part 53 Subpart Comparison

Subpart Title	Framework A Subpart	Framework B Subpart
General Provisions	Subpart A (Common)	
Technology-Inclusive Safety Requirements	Subpart B	-
Design and Analysis Requirements	Subpart C	
Siting Requirements	Subpart D	(Part 100)
Definitions	-	Subpart N
Construction and Manufacturing Requirements	Subpart E	Subpart O
Requirements for Operation	Subpart F	Subpart P
Decommissioning Requirements	Subpart G	Subpart Q
Licenses, Certifications, and Approvals	Subpart H	Subpart R
Maintaining and Revising Licensing Basis Information	Subpart I	Subpart S
Reporting and Other Administrative Requirements	Subpart J	Subpart T
Quality Assurance Criteria	Subpart K	Subpart U

Framework B Development Approach

Incorporate Applicable Existing Part 53 Framework Innovations

Leverage Part 50 and 52 Rule Language



Consider Compatibility with International Standards

Develop Unique Rule Language

Consider state-of-practice research and experience with other improvements to regulatory structure and licensing processes

Subpart N – Definitions

- Definitions specific to Framework B
  - Anticipated operational occurrence (AOO)
  - Design bases
  - Reactor coolant pressure boundary
  - Safety-related structures, systems, and components (SSCs)

- Common definitions remain in Subpart A (§ 53.020)

Subpart O – Construction and Manufacturing Requirements

- Parallel structure and content to Framework A Subpart E
- Variations largely limited to conforming changes needed to adapt Framework A provisions to Framework B

Subpart P – Requirements for Operation

§ 53.4210	Maintenance, repair, and inspection programs.
§ 53.4213	Technical specifications.
§§ 53.4220 - 53.4299	General staffing, training, personnel qualifications, and human factors requirements.
§ 53.4300	Programs.
§ 53.4310	Programs: Radiation protection.
§ 53.4320	Programs: Emergency preparedness.
§ 53.4330	Programs: Security programs.
§ 53.4340	Programs: Quality assurance.
§ 53.4350	Programs: Fire protection.
§ 53.4360	Programs: Inservice inspection/inservice testing.
§ 53.4380	Programs: Environmental qualification of electric equipment
§ 53.4390	Programs: Procedures and guidelines.
§ 53.4400	Programs: Integrity assessment program.
§ 53.4410	Programs: Primary containment leakage rate testing program.

Subpart P – Requirements for Operation

- Maintenance, repair, and inspection programs generally aligned with § 50.65
- Technical specifications generally aligned with § 50.36
- Programs
  - Security, Emergency Preparedness, Radiation Protection requirements aligned with Framework A
  - Environmental qualification of electrical equipment derived from § 50.49
  - Scope of SSCs in Integrity Assessment Program aligned more closely with § 53.4210(b) (§ 50.65(b))
  - Containment leak rate requirements from Part 50 (§ 50.54(o))

Subpart P – Requirements for Operation

Staffing, Training, Personnel Qualifications, and Human Factors

- Framework B adopts most requirements from Framework A through cross-references or copying requirements with some minor changes
- Staffing plan requirements in § 53.4226(f) include the need for "engineering expertise" availability to support on-shift operating personnel
  - Must be familiar with facility operation and meet at least one educational or credential requirement in §§ 53.4226(f)(1)(i) through (f)(1)(iii)
  - Developed in response to ACRS feedback on blanket removal of shift technical advisor position
- Framework A's provisions for alternatives to the use of licensed Reactor Operators and Senior Reactor Operators are not currently translated to Framework B; the staff will continue to evaluate options in this area

Subpart P – Requirements for Operation

Fire Protection

- Combination of § 50.48, Appendix R, and NFPA 805 Chapter 3
  - All requirements are contained in “in-line” rule text
    - No appendices in Part 53
    - No cross-references back to Parts 50 or 52
- No fire PRA required, but may be useful in performance-based justifications
  - Provision for performance-based alternatives to detailed requirements with NRC approval (like § 50.48(c)(2)(vii) and § 50.48(c)(4))
- Technology neutral
  - Designers must define the “safe and stable state” for their design
  - Designers must determine the safe shutdown functions to achieve and maintain safe and stable state

Subpart Q – Decommissioning Requirements

- Parallel structure and content to Framework A Subpart G
- Variations largely limited to conforming changes needed to adapt Framework A provisions to Framework B

Subpart S – Maintaining and Revising Licensing Basis Information

- Parallel structure and content to Framework A Subpart I
- Notable differentials
  - § 53.6010, *Application for amendment of license*
  - § 53.6040, *Updating licensing basis information and determining the need for NRC approval*
  - § 53.6045, *Updating final safety analysis reports*
  - § 53.6050, *Evaluating changes to facility as described in final safety analysis reports*
  - § 53.6052, *Maintenance of risk evaluations*
- Remaining variations largely limited to conforming changes to adapt Framework A provisions to Framework B

Subpart T – Reporting and Other Administrative Requirements

- Parallel structure and content to Framework A Subpart J
- Notable differentials
  - § 53.6320(e) added to align with state-of-practice policy initiative on reporting requirement for fee purposes
  - § 53.6330, *Immediate notification requirements for operating commercial nuclear plants*, aligned with § 50.72
  - § 53.6340, *Licensee event report system*, aligned with § 50.73
- Remaining variations largely limited to conforming changes to adapt Framework A provisions to Framework B

Subpart U – Quality Assurance

- Subpart U parallels structure and content of Framework A Subpart K
- Closely aligned with 10 CFR Part 50 Appendix B (18 criteria)
- Exception: § 53.6635, *Control of Purchased Material, Equipment and Services* (10 CFR Part 50 Appendix B Criterion VII)
  - “Commercial nuclear plant” used in lieu of “nuclear power plant”
  - Ensures consistency with terminology throughout Part 53

Subpart R – Licenses, Certifications, and Approvals

§ 53.4700	General Provisions.
§ 53.4725	Standards for review.
§ 53.4730	**General technical requirements.**
§ 53.4731	Risk-informed classification of structures, systems, and components.
§ 53.4740	Limited work authorizations.
§ 53.4750	Early site permits.
§ 53.4800	Standard design approvals
§ 53.4830	Standard design certifications.
§ 53.4870	Manufacturing licenses.
§ 53.4900	Construction permits.
§ 53.4960	Operating licenses.
§ 53.5010	Combined licenses.

Subpart R – Licenses, Certifications, and Approvals

- Subpart R developed to parallel Subpart H in Framework A
  - Covers all application types (e.g., Construction Permit (CP), Operating License (OL), Combined License (COL))
  - Process-related requirements (e.g., duration of a license) similar or the same between frameworks
  - Technical contents of application structures derived from Parts 50 and 52 and represent primary differentiator between Subparts H and R
  - Includes § 53.4731 that parallels § 50.69 regarding risk-informed SSC classification

Subpart R – Licenses, Certifications, and Approvals

- Section § 53.4730, *General technical requirements,* consolidates technical content of application requirements for the various application types
  - COL technical contents of application (§ 52.79) used as a starting point
  - Each application type references back to § 53.4730
    - Reduces rule length
    - Minimizes the potential for requirements to diverge between application types

Application Type

53.4730(a) Requirement	COL	OL	CP	ML	DC	SDA	ESP
(1)	X	X	X	X	X	X	X
(2)	X	X	X	X	X	X	X
(3)	X	X		X	X	X	X
…							
(37)	X	X	X	X	X	X	X

Subpart R – Licenses, Certifications, and Approvals

Accident Analyses and Initiating Event Requirements

- Requirements in § 53.4730(a)(5) derived from previous "Part 5X" work undertaken in 2021 that proposed technology-inclusive alternatives to some requirements in Parts 50 and 52
- **AOOs** (§ 53.4730(a)(5)(iii)): Requirements consistent with existing requirements in traditional frameworks with Part 20 acceptance criteria
- **Design Basis Accidents (DBAs)** (§ 53.4730(a)(5)(ii)): New technology-neutral requirements for DBA analyses and SSC classification based loosely on §§ 50.34(a)(4) and 50.46
- **Beyond Design Basis Events (BDBEs)** (§ 53.4730(a)(5)(iv)): Provides technology-inclusive requirements for relevant BDBEs and analysis requirements for other BDBEs, drawn from Anticipated Transient Without Scram/Station Black Out rulemakings; similar to international defense in depth requirements.
- **Severe Accidents** (§ 53.4730(a)(5)(v)): Derived from current requirements in § 52.79(a)(38), with modifications made to support technology-inclusiveness
- **Chemical Hazards** (§ 53.4730(a)(5)(vi)): Requirements based on language proposed in Framework A to address potential chemical hazards associated with licensed material

Subpart R – Licenses, Certifications, and Approvals Assessing Risk in Framework B

- Risk insights support or complement deterministic analyses, consistent with traditional approach
- Includes requirement to provide a description of the plant-specific PRA and its results translated to Framework B

§ 52.79(a)(44) → § 53.4730(a)(34)(i)

- Optional alternative risk evaluation for applicants that meet the criteria in § 53.4730(a)(34)(ii)
  - No PRA required
  - Implicitly demonstrates that quantitative health objectives (QHOs) are met, searches for severe accident vulnerabilities, and provides risk insights without a requirement for a PRA
  - Inherently addresses the mitigation of beyond-design-basis events requirements when AERI entry criteria are met
  - Cannot implement risk-informed applications if AERI approach is used
- Risk evaluations (PRA or AERI) must be maintained consistent with requirements in Subpart S (§ 53.6052, informed by § 50.71(h))

Alternative Evaluation for Risk Insights

- Evolved from the staff's "graded PRA" initiative starting in Spring 2021
  - Grade the technical content of the PRA
  - Grade the uses of the PRA in the design and licensing process
    - PRA in an enhanced/leading role
    - PRA in a supporting/confirmatory/traditional role
- Various names have been used to describe the concept:
  - Dose/consequence-based approach
  - Technology-inclusive, risk-informed maximum accident (TIRIMA) approach
  - Part 53-BE (bounding event)
  - AERI

Uses of PRA

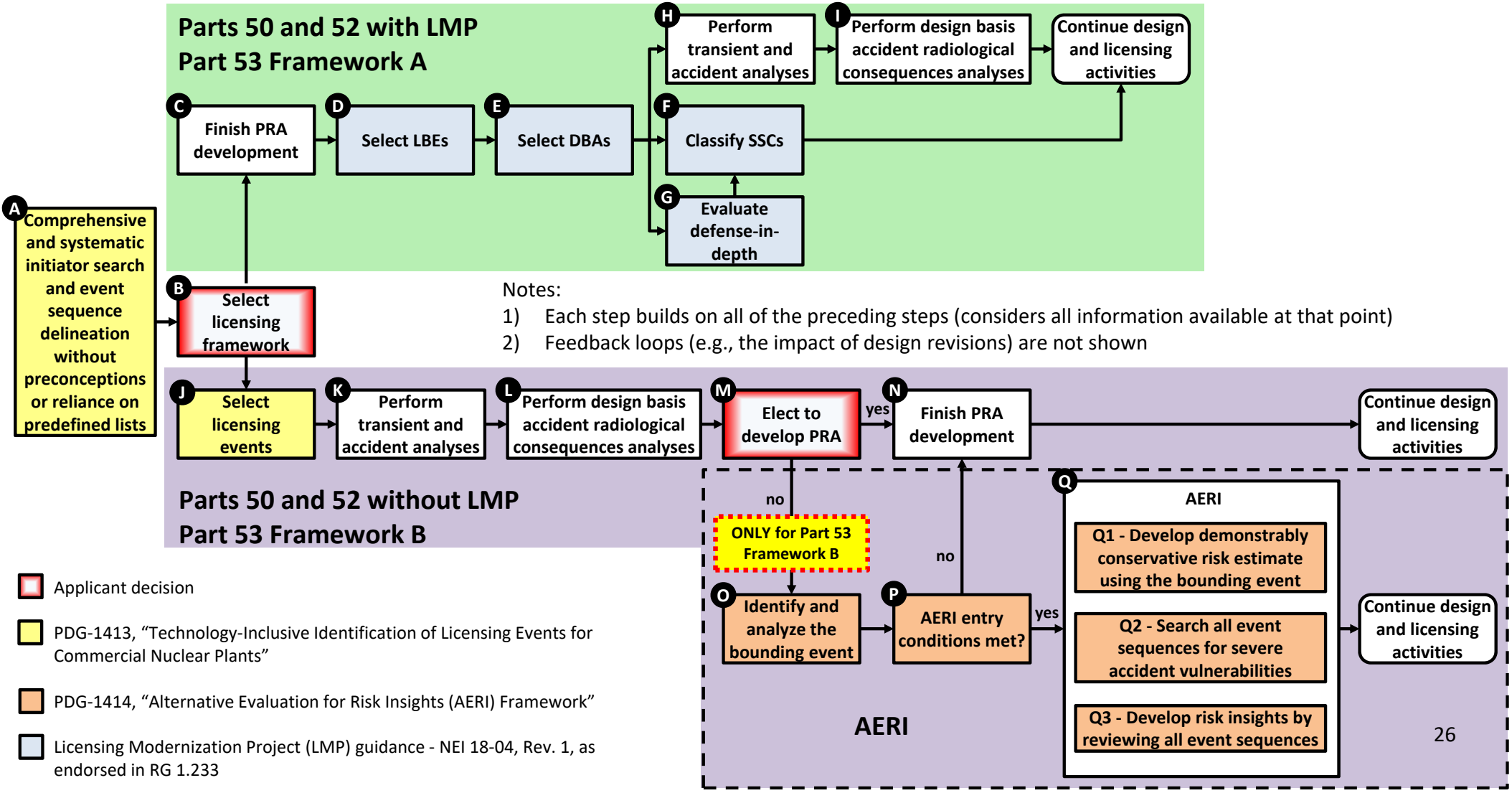
- The Policy Statement on the Regulation of Advanced Reactors (73 FR 60612; October 14, 2008) references three PRA-related policy statements:
  - Safety Goals for the Operation of Nuclear Power Plants (51 FR 28044; August 4, 1986 as corrected and republished at 51 FR 30028; August 21, 1986)
    - ⇨ Meet the QHOs
  - Severe Reactor Accidents Regarding Future Designs and Existing Plants (50 FR 32138; August 8, 1985)
    - ⇨ Search for severe accident vulnerabilities
  - Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities (60 FR 42622; August 16, 1995)
    - ⇨ Identify risk insights

- The AERI approach and two pre-decisional draft regulatory guides (PDGs) have been developed to:
  - Provide sufficient risk information to inform licensing decisions
  - Address related ACRS recommendations

ACRS Recommendations

- October 7, 2019 - Letter concerning review of draft SECY paper, "Population – Related Siting Considerations for Advanced Reactors," ML19277H071:
  - Need to examine new designs with a clean sheet of paper.
  - Think carefully about the failures and combinations of failures that could occur.
  - Must remain vigilant and remember that nature provides surprises.
  - Creative thinking will be required to identify such unique situations, to thoroughly identify the scenarios that will be the basis of the safety analysis and the source of releases, and to evaluate the suitability of sites.
- October 20, 2020 - Letter concerning 10 CFR Part 53, ML20091L698:
  - Compensate for novel designs with uncertainties due to incompleteness in the knowledge base by performing systematic searches for hazards, initiating events, and accident scenarios with no preconceptions that could limit the creative process.
- May 5, 2021 - Letter concerning Part 53, ML21140A354:
  - Compensate for novel designs with uncertainties due to incompleteness in the knowledge base by performing systematic searches for hazards, initiating events, and accident scenarios with no preconceptions that could limit the creative process.
- October 26, 2021 - Letter concerning RG 1.247, ML21288A018:
  - Include guidance that the initial search for initiating events and scenarios should be done without preconceptions or using existing lists.

Licensing Frameworks – Risk Evaluation Perspective



Notes:

1) Each step builds on all of the preceding steps (considers all information available at that point)
2) Feedback loops (e.g., the impact of design revisions) are not shown

- Applicant decision
- PDG-1413, "Technology-Inclusive Identification of Licensing Events for Commercial Nuclear Plants"
- PDG-1414, "Alternative Evaluation for Risk Insights (AERI) Framework"
- Licensing Modernization Project (LMP) guidance - NEI 18-04, Rev. 1, as endorsed in RG 1.233

Proposed 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 PRA, or

(ii) An AERI, provided that the dose from a postulated bounding event to an individual located 100 meters (328 feet) away from the commercial nuclear plant does not exceed 1 rem total effective dose equivalent (TEDE) over the first four days following a release, an additional 2 rem TEDE in the first year, and 0.5 rem TEDE per year in the second and subsequent years.

- Provides plants with flexibility in establishing their exclusion area boundaries if the bounding event's source term is small.
- The 100-meter criterion was back-calculated from a scoping consequence model:
  - 50-year dose at 100 meters = 27.5 rem TEDE
  - Conditional individual latent cancer fatality risk = 2×10^{-6} per event
  - Meet the QHO without developing a PRA to credit accident frequency in the risk estimate
- Some stakeholders have confused the AERI entry conditions with safety/siting criteria.

Technology-Inclusive Identification of Licensing Events for Commercial Nuclear Plants (Pre-decisional DG-1413)

- Formatted like a regulatory guide; currently a pre-decisional draft regulatory guide
- Section A: Applies to light water reactors (LWRs) and non-LWRs licensed under Parts 50, 52, and 53 (Frameworks A and B)
- Section B:
  - 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 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:
  - Recommends the use of one inductive method and one deductive method when searching for initiating events
  - Points the user to helpful references (NRC, IAEA, IEC, ASME/ANS, AIChE, EPRI, open literature)
  - Does not endorse or recommend any specific method

Alternative Evaluation for Risk Insights (AERI) Framework (Pre-decisional DG-1414)

- Formatted like a regulatory guide; currently a pre-decisional draft regulatory guide
- Section A: Only applies to LWRs and non-LWRs licensed under Part 53 Framework B
- Sections B & C: Components of the AERI approach:
  - Identification and characterization of the bounding event
  - Definition of a bounding event
    - Multiple events may need to be considered as bounding events
  - Determination of a consequence estimate for the bounding event to confirm that the reactor design meets the AERI entry conditions
  - Determination of a demonstrably conservative risk estimate for the bounding event to demonstrate that the QHOs are met
    - Assumed frequency of 1/yr consistent with frequency of all event sequences for LWRs
    - Applicant may use a lower frequency with justification
  - Search for severe accident vulnerabilities for the entire set of licensing events
    - Definitions of severe accident and severe accident vulnerability
  - Identification of risk insights for the entire set of licensing events
  - Assessment of defense-in-depth adequacy for the entire set of licensing events

Framework B Guidance Development

Many Framework A and B guidance development activities are linked

May involve updates or supplements to existing guidance covering existing regulatory frameworks

Guidance for technical content of application requirements now part of Advanced Reactor Content of Application Project effort

Areas of Focus for Merger of Frameworks A and B

Ensure consistency between parallel provisions

Evaluate other provisions for potential alignment

- Siting
- Seismic Design Criteria
- Requirements for Operation

Commonalities in Subpart A

- Definitions
- General Provisions

Continue consideration of stakeholder feedback

Next Steps

- Advisory Committee on Reactor Safeguards
  - Subcommittee: June 23 - 24, 2022
  - Full Committee: July 6 - 9, 2022
- Advanced Reactor Public Stakeholder Meeting: June 30, 2022
- Commission Meeting: July 21, 2022

Additional Information

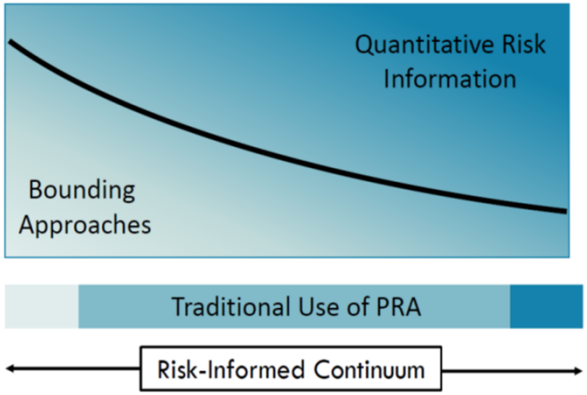
- Additional information on the 10 CFR Part 53 rulemaking is available at https://www.nrc.gov/reactors/new-reactors/advanced/rulemaking-and-guidance/part-53.html
- For information on how to submit comments go to https://www.regulations.gov and search for Docket ID NRC-2019-0062
- For further information, contact Robert Beall, Office of Nuclear Material Safety and Safeguards, telephone: 301-415-3874; email: Robert.Beall@nrc.gov

Acronyms

ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Management System
AERI	Alternative evaluation of risk insights
AIChe	American Institute of Chemical Engineers
ANS	American Nuclear Society
AOO	Anticipated operational occurrence
ASME	American Society of Mechanical Engineers
BDBE	Beyond design basis event
BE	Bounding event
CFR	Code of Federal Regulations
COL	Combined license
CP	Construction permit
DBA	Design basis accident
DC	Design certification
EPRI	Electric Power Research Institute
ESP	Early site permit
FR	*Federal Register*
IAEA	International Atomic Energy Agency
IEC	The Incident and Emergency Centre
LBE	Licensing basis event
LMP	Licensing Modernization Project
LWR	Light water reactor
ML	Manufacturing license
NEI	Nuclear Energy Institute
NFPA	National Fire Protection Association
NRC	U.S. Nuclear Regulatory Commission
OL	Operating license
PDG	Pre-decisional draft regulatory guide
PRA	Probabilistic risk assessment
QHO	Quantitative health objective
RG	Regulatory guide
SDA	Standard design approval
SSCs	Structures, systems, and components
TEDE	Total effective dose equivalent
TIRIMA	Technology-inclusive, risk-informed maximum accident

Backup Slides

Regulatory Framework Options



Framework B: Emphasis Design Criteria

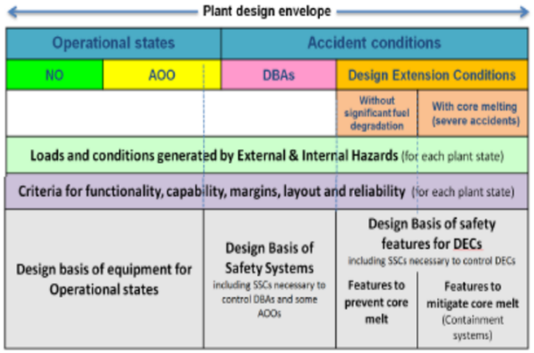


FIG. 2. Main elements of the design basis of SSCs for different plant states.

- *Traditional approach represented by figure from IAEA guidance.*

Framework A: Emphasis Risk Metrics and Insights

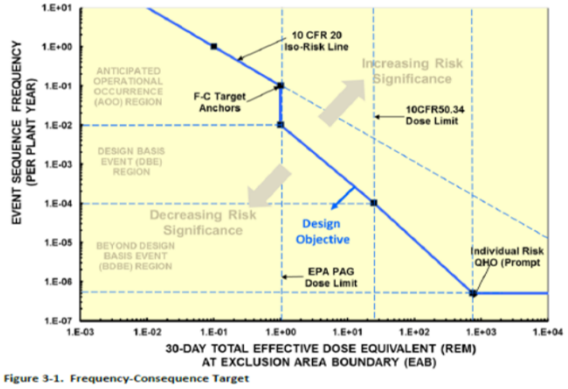


Figure 3-1. Frequency-Consequence Target

- *With addition of DBA used to set design criteria and performance objectives for the design of Safety Related SSCs.*

Derivation of AERI Entry Conditions (1 of 7)

1

Risk, R, is the sum of the products of frequency, f_i, and consequence, c_i, over the set of delineated event sequences.

$$R = \sum f_i c_i$$

2

Suppose we can identify a bounding event.

$$c_{max} = \max(c_1, c_2, \ldots, c_n)$$

3

Then we can bound the risk.

$$R \leq \left(\sum f_i \right) c_{max}$$

4

$\sum f_i$ = sum of the initiating event frequencies
≈ 1/plant-year, based on large LWR history

This demonstrably conservative approach eliminates the need to estimate the individual event sequence frequencies by developing a PRA.

Derivation of AERI Entry Conditions (2 of 7)

5

There are two quantitative health objectives (QHOs):

- Individual early fatality risk (IEFR)
- Individual latent cancer fatality risk (ILCFR)

$$IEFR \leq 5 \times 10^{-7}$$
$$ILCFR \leq 2 \times 10^{-6}$$

Justification for these values is provided in NUREG-0880, Rev. 1, pp. 30-31.

6

Focus on ILCFR:

- Part 53, Framework B has been developed to provide the same level of safety as currently operating plants.
- The State-of-the-Art Reactor Consequence Analysis (SOARCA) studies indicate that IEFR is essentially zero.

c_{max} = conditional latent cancer fatality risk, $CILCFR$, of the bounding event

$$ILCFR \leq \frac{1}{year} \times CILCFR \leq 2 \times 10^{-6}$$

7

$E[N_{LC}]$ = expected number of latent cancer fatalities within 10 miles of the site over 50 years following occurrence of the bounding event

N_T = total population within 10 miles of the site

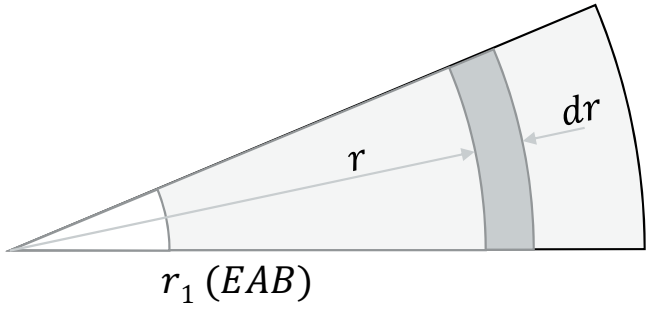
$$\text{CILCFR} = \frac{E[N_{LC}]}{N_T}$$

Derivation of AERI Entry Conditions (3 of 7)

8

Assume that the plume is confined to one of sixteen 22.5-degree sectors.

$E[N_{LC}]$ = expected number of latent cancer fatalities in the 10-mile, 22.5° sector over 50 years following occurrence of the bounding event



$$22.5° = \frac{\pi}{8}\ radians$$

9

Assume a uniform population density, ρ.

This assumption eliminates the need to consider the wind direction

Derivation of AERI Entry Conditions (4 of 7)

10

On a differential basis, the number of latent cancer fatalities is a random variable that is characterized by a binomial probability distribution:

$$dN_{LC} \sim Binomial[p_{LC}(r), dN(r)]$$

Accordingly, the expected (mean) value is:

$$E[dN_{LC}] = p_{LC}(r) \cdot dN(r)$$

$p_{LC}(r)$ = probability that an individual located at distance r dies within 50 years

$dN(r)$ = differential number of individuals in the 22.5° sector that are located between r and r + dr

11

Apply the linear no-threshold model, which relates cumulative radiation exposure to fatality risk.

$$p_{LC}(r) = \lambda \cdot D(r)$$

The Commission affirmed the NRC's use of the LNT model in SRM-SECY-19-0008, July 16, 2021.

λ = risk coefficient (per rem)

$\approx 6 \times 10^{-4}$ according to BEIR-VII*

$D(r)$ = 50-year dose at distance r (rem)

*National Research Council. 2006. Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2. Washington, DC: The National Academies Press.

Derivation of AERI Entry Conditions (5 of 7)

12

Assume a power-law dose vs. distance model:

$$D(r) = D_0 \left(\frac{r_0}{r}\right)^{1.5}$$

The subscript "0" refers to an arbitrary reference location and dose.

Consistent with NUREG-0396, "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants," November 1978.

13

$$E[N_{LC}] = \int_{r_1}^{r_1+10} p_{LC}(r) \cdot dN(r)$$

$$= \int_{r_1}^{r_1+10} \lambda D_0 \left(\frac{r_0}{r}\right)^{1.5} \cdot \rho \cdot \frac{1}{16} \cdot 2\pi r dr$$

$$= \frac{\pi \rho \lambda D_0 r_0^{1.5}}{4} \left(\sqrt{r_1 + 10} - \sqrt{r_1}\right)$$

Integrate over the 10-mile area surrounding the site.

Apply the uniform population density, LNT, and power-law dose vs. distance assumptions.

$E[N_{LC}]$ = expected number of latent cancer fatalities in the 10-mile, 22.5° sector over 50 years following occurrence of the bounding event

Derivation of AERI Entry Conditions (6 of 7)

14

The total population in the 10-mile area is:

$$N_T = \rho \cdot \pi[(r_1 + 10)^2 - r_1^2]$$
$$= 20\rho\pi(r_1 + 5)$$

Apply the uniform population density assumption.

15

$$CILCFR = \frac{\lambda D_0 r_0^{1.5}}{80} \cdot \frac{\left(\sqrt{r_1 + 10} - \sqrt{r_1}\right)}{r_1 + 5}$$

Scoping consequence model.

Note: $CILCFR$ decreases as r_1 increases.

16

$$CILCFR \leq \frac{\lambda D_0 r_0^{1.5}\sqrt{10}}{400} \leq QHO$$

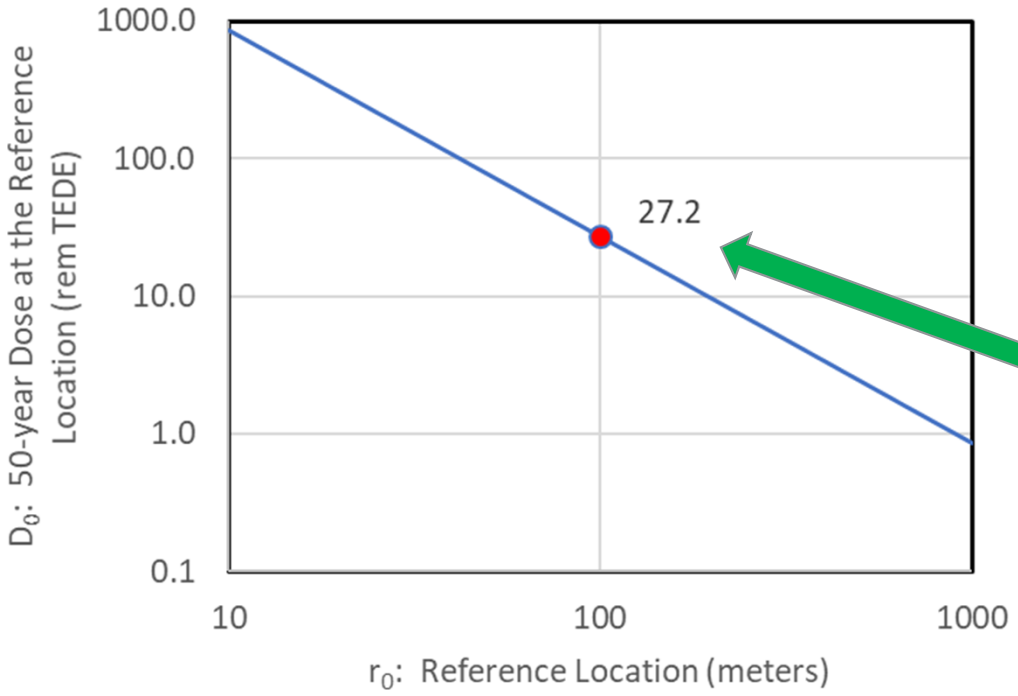
Upper bound of the scoping consequence model

$$D_0 r_0^{1.5} \leq \frac{400 \cdot QHO}{\sqrt{10}\lambda} \approx 0.422$$

Criterion for the reference point

Derivation of AERI Entry Conditions (7 of 7)

17



Dose (rem TEDE)	Condition
1	First 96 hours
2	Additional dose during the 1st year
0.5 x 49 = 24.5	Additional dose during the second and subsequent years
27.5	TOTAL

Note: The reference location is not necessarily the same as the EAB