

# **Trial Use RG 1.247 “Acceptability of Probabilistic Risk Assessment Results for Advanced Non-Light Water Reactor Risk-informed Activities”**

Briefing for the Advisory Committee on Reactors Safeguards  
Subcommittee on Future Plant Designs

Michelle Gonzalez, RES  
Anders Gilbertson, RES  
Hanh Phan, NRR  
Martin Stutzke, NRR  
Karl Fleming, JCNRM  
Dennis Henneke, JCNRM  
Donna Williams, NRR

September 20, 2021

# Presentation Outline

1. Background (Michelle Gonzalez)
2. Approach to Developing RG 1.247 (Anders Gilbertson)
3. Scope of the Endorsement RG and Staff Position Issues Addressed in RG (Hanh Phan/Martin Stutzke)
4. Future Activities/Revision of Non-LWR PRA Standard (Karl Fleming/Dennis Henneke)
5. Next Steps and Stakeholder Engagement (Donna Williams)

# Background

Michelle Gonzalez, RES

# Background

- The advanced non-light water reactor (ANLWR) PRA standard (ASME/ANS RA-S-1.4-2013) was issued in 2013 by ASME/ANS for trial use.
- In February 2021, ASME and ANS jointly issued ASME/ANS RA-S-1.4-2021, “Probabilistic Risk Assessment Standard for Advanced Non- Light Water Reactor Nuclear Power Plants”
  - The scope of the standard includes all levels of analysis (i.e. from initiating event to radiological consequence), all hazards and all operating modes (except internal fire PRA for LPSD-types of POSs).
  - The requirements in this standard cover PRAs performed during design, pre-operational, and post-operational phases.

# Background (cont'd)

- ACRS Subcommittee on Future Plant Designs-  
November 2, 2020
  - Staff discussed the updated endorsement plan and the ballot results
- Updates from last ACRS meeting
  - Draft white paper issued January 15, 2021 (ML21015A434)
  - Performance of PRA Peer Reviews Using the ASME/ANS Advanced Non-LWR PRA Standard issued May 5, 2021 (NEI 20-09)
  - Pre-decisional trial use RG made public September 7, 2021 (ML21246A216)

# **Draft White Paper: Demonstrating the Acceptability of PRA Results Used to Support Advanced Non-LWR Plant Licensing**

- Purpose: to provide staff views and perspectives on demonstrating acceptability of PRA results
- Provided early communication to stakeholders on issues to be addressed in RG 1.247
  - Public meeting held on February 23, 2021
  - Issues not addressed in RG 1.247 will be included in later documents

# Endorsement of the Non-LWR PRA Standard and NEI 20-09

- NLWR PRA Standard will be endorsed with a trial use RG
  - Trial use will allow for incorporation of lessons learned from early use and incorporation of ongoing regulatory efforts (10 CFR Part 53)
  - Comments accepted throughout the trial use period (Informal comment period)
  - Formal comment period to follow after the draft RG is issued
- Peer Review Guidance in NEI 20-09
  - Clean endorsement with no exceptions taken

# **Approach to Developing RG 1.247**

Anders Gilbertson, RES



# Topics

- RG 1.247 regulatory paradigm
- RG 1.247 development approach
- RG 1.247 v. RG 1.200 comparison
- Novel staff positions in RG 1.247

# RG 1.247 Regulatory Paradigm (1 of 2)

- RG 1.247 may be used to meet regulatory requirements related to the use of PRA
- The use of RG 1.247 helps *reduce* the need for an in-depth review of the PRA (RG 1.200 relates to *obviating* the need)
- RG 1.247 defines an application more broadly to accommodate design, pre-, and post-operational regulatory activities

# RG 1.247 Regulatory Paradigm (2 of 2)

- Guidance on NLWR PRA peer review considers that peer reviews are not required (consistent with DC/COL-ISG-028)
- However, RG 1.247 emphasizes the importance and utility of the peer review process and suggests that a pre-application peer review be performed
  - Promotes more efficient staff reviews of applications
- With the existing regulations, the staff have greater latitude to request information about an applicant's PRA

# RG 1.247 Development Approach (1 of 2)

- RG 1.200 is the starting point for RG 1.247
  - Organization and substance of content in RG 1.247 broadly mimics that of RG 1.200
- Staff positions in RG 1.247 consider the close relationships between the NLWR and LWR PRA standards
- Staff have considered the potential impact on future endorsements of LWR PRA standards

## **RG 1.247 Development Approach (2 of 2)**

- An information database tool was developed to help identify relationships and analyze differences between related requirements in different PRA standards and staff endorsements
- Applicability of current staff endorsement in RG 1.200 for related LWR PRA standard requirements were cross-checked against the NLWR PRA standard requirements

# RG 1.247 v. RG 1.200 Comparison (1 of 4)

## Some differences:

- RG 1.247 directly relates to meeting regulations
- RG 1.247 provides staff positions on the acceptability of PRA technical aspects for NLWRs that have not previously been provided for LWRs in RG 1.200
- RG 1.247 provides specific guidance on determining risk significance and the use of relative and absolute importance measures

# RG 1.247 v. RG 1.200 Comparison (2 of 4)

## Some differences:

- Consistent with the approach in the NLWR PRA standard, RG 1.247 does not use terms such as:
  - Level 1, Level 2, or Level 3 PRA
- RG 1.247 accommodates determining the acceptability of an NLWR PRA for an LMP application
- Because the staff identified no exceptions for NEI 20-09, the endorsement is only contained in the body of the RG
- Scope of RG 1.247 PRA elements not addressed in RG 1.200:
  - Plant Operating State Analysis for all POSs
  - Internal fire PRA for LPSD-types of POSs
  - Radiological consequence
  - Risk Integration

# RG 1.247 v. RG 1.200 Comparison (3 of 4)

## Some similarities:

- Most PRA elements addressed in RG 1.247 have an analog in RG 1.200, such as:
  - Initiating Event Analysis
  - Event Sequence Analysis
  - Success Criteria Development
  - Systems Analysis
  - Human Reliability Analysis
  - Data Analysis
  - Internal Flood PRA
  - Internal Fire PRA
  - Seismic PRA
  - Hazards Screening Analysis
  - High Wind PRA
  - External Flood PRA
  - Other Hazards PRA
  - Event Sequence Quantification
  - Mechanistic Source Term Analysis



# RG 1.247 v. RG 1.200 Comparison (4 of 4)

## Some similarities:

- Both include a table of hazards to consider in the development of a PRA
- Both provide guidance to applicants and licensees on:
  - What is an acceptable PRA (Section C.1)
  - The use of voluntary consensus standards and an acceptable peer review process (Section C.2)
  - How to demonstrate acceptability of PRA for an application (Section C.3)
  - PRA documentation needed to support a regulatory decision (Section C.4)

# Novel Staff Positions in RG 1.247 (1 of 5)

- Plant Operating State Analysis for all POSs
  - (Section C.1.3.1)
- Internal fire PRA for LPSD-types of POSs
  - (Section C.1.3.9)
- Radiological consequence
  - (Section C.1.3.17)
- Risk integration
  - (Section C.1.3.18)

## **Novel Staff Positions in RG 1.247 (2 of 5): Plant Operating States Analysis, all POSs**

- Staff position in RG 1.247 goes beyond the scope of RG 1.200 to address all POSs
- Considers that there may be more than one type of at-power POS (e.g., online refueling)
- Staff position accounts for the potential need for a similar staff position for LWRs

## **Novel Staff Positions in RG 1.247 (3 of 5): Internal Fire PRA, LPSD-Types of POSs**

- No analogous staff positions for LWRs
- The NLWR PRA standard does not provide related requirements; as such, acceptability is measured against the staff position in Section C.1.3.9 of RG 1.247
- Staff position accounts for the potential need for a similar staff position for LWRs
- NRC initiating a research project to develop guidance

# **Novel Staff Positions in RG 1.247 (4 of 5): Radiological Consequence**

- An LMP application evaluates frequency and radiological consequence risk
- Outside of LMP applications, there are no regulatory requirements to perform a PRA that assesses consequence risk
- However, it is still important to meet Commission expectations as expressed in various policy statements
- Risk surrogates used for NLWRs will need to be justified

# **Novel Staff Positions in RG 1.247 (5 of 5): Risk Integration**

- No staff position on risk integration has previously been promulgated
- Basis for staff position relates to meeting Commission expectations, as expressed in the Advanced Reactor Policy Statement, which in turn references the Safety Goal Policy Statement and the importance of meeting the QHOs
- Unless justified, relative risk significance criteria should be used to develop the PRA.
- Staff determination of PRA acceptability does not include consideration of risk reporting thresholds

# **Scope of RG 1.247 and Staff Positions on Non-LWR PRA Standard**

Hanh Phan, NRR

## RG 1.247 Guidance

RG 1.247 provides guidance, for trial use, in the following four areas:

1. Defining the acceptability of a PRA and its results used in support of an application – **RG 1.247, Section C.1**
2. Demonstrating the acceptability of the PRA and its results used in an application – **RG 1.247, Section C.3**
3. Documentation to support a regulatory decision – **RG 1.247, Section C.4**
4. Staff's positions on NLWR PRA standard and industry PRA peer review process – **RG 1.247, Section C.2 and Appendix A**



# Technical Reviewers

| Technical Element                 | NRC Reviewer     |
|-----------------------------------|------------------|
| Plant Operating States Analysis   | Marie Pohida     |
| Initiating Event Analysis         | Keith Tetter     |
| Event Sequence Analysis           | Keith Tetter     |
| Success Criteria Analysis         | Keith Tetter     |
| Systems Analysis                  | Hanh Phan        |
| Human Reliability Analysis        | Jonathan DeJesus |
| Data Analysis                     | Hanh Phan        |
| Internal Flood PRA                | Matt Humberstone |
| Internal Fire PRA                 | JS Hyslop        |
| Internal Fire PRA LPSD            | JS Hyslop        |
| Seismic PRA                       | Shilp Vasavada   |
| Hazard Screening Analysis         | Alissa Neuhausen |
| High Winds PRA                    | John Lane        |
| External Flooding PRA             | Shilp Vasavada   |
| Other Hazards PRA                 | Alissa Neuhausen |
| Event Sequence Quantification     | Hanh Phan        |
| Mechanistic Source Term Analysis  | Michelle Hart    |
| Radiological Consequence Analysis | Keith Compton    |
| Risk Integration                  | Susan Cooper     |
| Newly Developed Methods           | Shilp Vasavada   |
| Peer Review                       | Hanh Phan        |

# NLWR PRA Scope

- Address all radiological sources at the plant
  - Reactor cores
  - Spent fuel
  - Fuel reprocessing facilities
  - Accident scenarios that lead to a radioactive release from multiple radiological sources
- Address all hazards
  - All internal hazards such as, but not limited, to internal initiating events, internal floods, and internal fires
  - All external hazards such as, but not limited to, seismic events, external floods, and high wind events
- Address all plant operating states (e.g., at-power, low-power, shutdown)
- NLWR PRA should be a Level 3 PRA
  - Develop the frequencies of accident scenarios from the occurrence of an initiating event until the release of radioactive materials to the environment
  - Estimate the consequences that result from the release

# Applicable Regulations and Applications

- This RG applies to applications for NLWR licensing under 10 CFR Part 50
  - Current regulations do not require applicants for Part 50 construction permits or operating licenses to provide PRA-related information
  - Rulemaking “Incorporation of Lessons Learned from New Reactor Licensing Process (Parts 50 and 52 Licensing Process Alignment),” Docket NRC-2009-0196, RIN-3150-AI66
- This RG applies to applications for NLWR licensing under 10 CFR Part 52
  - Subpart B - Standard Design Certification (DC)
  - Subpart C - Combined License (COL)
  - Subpart E - Standard Design Approval (SDA)
  - Subpart F - Manufacturing License (ML)
- This RG is coordinated with 10 CFR Part 53 rulemaking effort
  - Rulemaking “Risk Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors,” Docket NRC-2019-0062, RIN 3150-AK31
  - Being developed as required by the Nuclear Energy Innovation and Modernization Act (NEIMA)

# Applicability of RG 1.247

Applies to only stationary NLWRs:

- Reactors that are constructed at a site
- Reactors that are constructed at an offsite facility and subsequently transported and installed at a site
- Does not address PRAs used to assess the risk of transporting NLWRs from an offsite facility to the site
- Does not address mobile reactors, which may be relocated to different sites after initial criticality

# Technical Elements

RG 1.247 endorses the following PRA standard technical elements:

1. Plant Operating State Analysis
2. Initiating Event Analysis
3. Event Sequence Analysis
4. Success Criteria Development
5. Systems Analysis
6. Human Reliability Analysis
7. Data Analysis
8. Internal Flood PRA
9. Internal Fire PRA
10. Seismic PRA
11. Hazards Screening Analysis
12. High Wind PRA
13. External Flooding
14. Other Hazards PRA
15. Event Sequence Quantification
16. Mechanistic Source Term Analysis
17. Radiological Consequence Analysis
18. Risk Integration

... and ASME/ANS RA-S-1.4-2021:

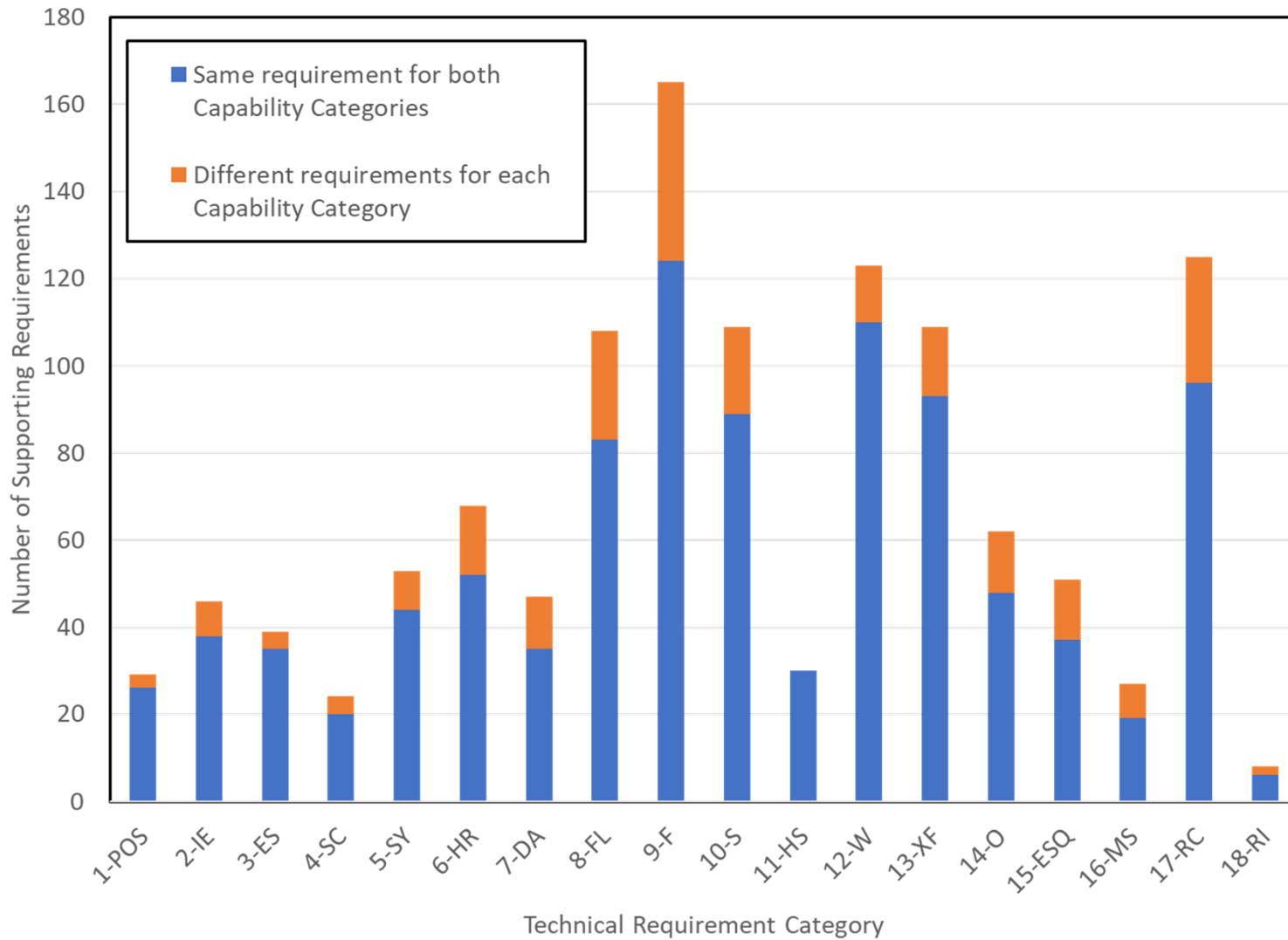
- Definitions and Risk Assessment Application
- PRA configuration control
- Peer review
- Newly Developed Methods

# Endorsement of Nonmandatory Appendices

- The nonmandatory appendices in ASME/ANS NLWR PRA standard may be binned into two groups:
  - a) Notes that support the understanding of various SRs, and
  - b) Commentaries
- The NRC staff generally accepts the “Notes”
- The NRC staff provides no opinion about the “Commentaries”

# Capability Categories

In general, about 20% of the supporting requirements distinguish between CC-I and CC-II



## **Section C.1 - Acceptability of a PRA and Its Results Used in Support of an Application**

- The staff assesses acceptability of the PRA and its results with respect to:
  - PRA scope
  - Level of detail
  - Conformance with consensus standard PRA elements
  - Plant representation of a PRA



# PRA Acceptability

## PRA Scope

- Metrics used to characterize risk
- Plant operating states (POSS) for which the risk is to be evaluated
- Causes of initiating events (hazard groups)

## PRA Level of Detail

- Defined in terms of the resolution of the modeling used to represent the behavior and operations of the plant
- A minimal level of detail is necessary to ensure that the impacts of designed-in dependencies are correctly captured

## PRA Acceptability

## PRA Technical Elements

- Defined in terms of the fundamental technical analyses needed to develop and quantify the base PRA model for its intended purpose
- The characteristics and attributes of PRA technical elements define specific requirements that should be met

## Plant Representation

- How closely the base PRA represents the plant as it is actually built and operated
- The PRA should be maintained and upgraded, where necessary, to ensure it represents the as-built and as-operated plant

## **Section C.3 - Demonstrating Acceptability of PRA and Its Results Used in an Application**

For all applications, the PRA-related information provided in the submittal should:

- Describe the PRA's scope, level of detail, and degree of plant representation
- Demonstrate that the PRA has been developed and used in a technically acceptable manner, including the appropriateness of the assumptions and approximations
- Identify the application-specific acceptance criteria and demonstrate that they have been met

## Section C.4 - Documentation to Support a Regulatory Decision

- Documentation of the PRA model and the analyses performed should comprise both:
  - Archival information (i.e., available for audit or inspection), and
  - submittal information (i.e., submitted as part of the risk-informed request)
- Archival PRA documentation may be required on an as-needed basis to facilitate the NRC staff's review of the application

## Section C. 4 - Documentation (continued)

Archival PRA documentation should include:

- The process used to determine the acceptability of the PRA
- The methodology used to assess the risk of the application
- SSCs, operator actions, and plant operational characteristics affected by the application
- How the cause-effect relationships are mapped onto the PRA elements
- The PRA results that will be used to compare against the applicable acceptance criteria
- The scope of risk contributors (hazard groups and modes of operation) included in the PRA to support the application
- The results of the peer reviews of the PRA, PRA upgrades, and use of NDMs, and the results of F&O independent assessments, the resolution of all of the peer reviews
- The processes for maintaining & upgrading the PRA and the use of NDMs

## Section C.4 - Documentation (continued)

Submittal PRA documentation should include:

- Demonstration that the PRA model represents the as-designed, as-to-be-built, and as-to-be-operated plant or the as-built and as-operated plant
- The appropriateness of key assumptions and approximations and sensitivity studies
- The appropriateness of a given portion of the PRA that meets a capability category lower than deemed required for the application under consideration
- The appropriateness of PRA model upgrades, including the use of NDMs, for the application under consideration

# Section C.2 and Appendix A - Staff Positions on PRA Standard and PRA Peer Review Process

- About 80% of the requirements in the NLRW PRA standard were taken as-is from the set of LWR PRA standards
- First consideration ballot for the ANLWR PRA standard (3/24/20 – 5/26/20)
  - NRC staff submitted 489 comments, represented a broad set of staff views and perspectives
- Recirculation ballot for the ANLWR PRA standard (7/23/20 – 8/26/20)
  - NRC staff submitted 70 comments, included a mix of proposed technical changes and observations related to regulatory issues

## Section C.2 and Appendix A - Staff Position on PRA Standard (continued)

The staff position on each requirement in ASME/ANS RA-S-1.4-2021 is categorized as:

- **No objection** - The staff has no objection to the requirement
- **No objection with clarification** - The staff has no objection to the requirement. However, certain requirements, as written, are either unclear or ambiguous, and therefore the staff has provided its understanding of these requirements
- **No objection subject to the following qualification** - The staff has a technical concern with the requirement and has provided a qualification to resolve the concern

# Rationale for the Staff Positions

- JCNRM did not address during ballot process stating that comment needs to be addressed first in the LWR Level 1/LERF PRA standard
- Regulatory issue
- New issue
- Issue was not adequately addressed during balloting
- Not fully addressed by JCNRM
- Added for consistency with the staff's position in RG 1.200, Rev. 3



# Clarification and Qualification Positions

| Table | Description                | Clarification | Qualification | Total      |
|-------|----------------------------|---------------|---------------|------------|
| A-1   | Front Matter               | 3             | 2             | 5          |
| A-2   | Plant Operating States     | 3             | 5             | 8          |
| A-3   | Initiating Events          | 0             | 0             | 0          |
| A-4   | Event Sequences            | 0             | 0             | 0          |
| A-5   | Success Criteria           | 0             | 0             | 0          |
| A-6   | Systems Analysis           | 5             | 0             | 5          |
| A-7   | Human Reliability Analysis | 7             | 4             | 11         |
| A-8   | Data Analysis              | 0             | 1             | 1          |
| A-9   | Internal Floods            | 7             | 1             | 8          |
| A-10  | Internal Fires             | 1             | 0             | 1          |
| A-11  | Seismic                    | 22            | 6             | 28         |
| A-12  | Hazard Screening           | 8             | 1             | 9          |
| A-13  | High Winds                 | 4             | 2             | 6          |
| A-14  | External Floods            | 14            | 1             | 15         |
| A-15  | Other Hazards              | 10            | 1             | 11         |
| A-16  | Quantification             | 0             | 0             | 0          |
| A-17  | Mechanistic Source Terms   | 0             | 0             | 0          |
| A-18  | Radiological Consequences  | 23            | 5             | 28         |
| A-19  | Risk Integration           | 6             | 2             | 8          |
| A-20  | Configuration Control      | 0             | 1             | 1          |
| A-21  | Peer Review                | 0             | 0             | 0          |
| A-22  | Newly Developed Methods    | 1             | 1             | 2          |
|       | <b>Totals</b>              | <b>114</b>    | <b>33</b>     | <b>147</b> |

# Substantive Clarifications and Qualifications

| Group                                | Clarifications | Qualifications | Total     |
|--------------------------------------|----------------|----------------|-----------|
| Group 1: Low Power and Shutdown Risk | 2              | 2              | 4         |
| Group 2: External Hazard Risk        | 4              | 2              | 6         |
| Group 3: Errors of Commission        | 0              | 2              | 2         |
| Group 4: Risk Significance           | 1              | 0              | 1         |
| Group 5: Reporting Requirements      | 2              | 2              | 4         |
| <b>Total</b>                         | <b>9</b>       | <b>8</b>       | <b>17</b> |

# Group 1 - Low Power and Shutdown Risk

| #   | Index No. | Issue   | Position      | Resolution   |
|-----|-----------|---|---------------|--|
| 1.1 | POS-N-2   | All stages of the licensing process should address low power and shutdown-types of evolutions   | Clarification | <del>Early pre-operational stage PRAs are typically limited to at-power PRAs only.</del> All stages of the licensing process should address low power and shutdown-types of evolutions   |
| 1.2 | POS-N-4   | All stages of the licensing process should address low power and shutdown-types of evolutions   | Clarification | <del>Depending on the application, the evolution to be addressed may range from at-power only to all plant operating states outage types.</del> All stages of the licensing process should address low power and shutdown-types of evolutions.   |
| 1.3 | POS-A1    | Limiting the CC-I requirement for POS-A1 only to at-power plant evolutions potentially excludes a significant risk contributor as low-power and shutdown-types of POSs have been shown to have a comparable risk in some cases to at-power POSs. As such, the scope of the CC-I requirement should be the same as the scope of the CC-II requirement to avoid excluding potentially significant contributors to risk. | Qualification | <del>CC-I<br/>IDENTIFY a representative set of plant evolutions to be analyzed.<br/>INCLUDE, at a minimum, plant evolutions from at-power operations.<br/>See Note POS-N-1, POS-N-2, POS-N-3, POS-N-4</del><br><u>CC-I and CC-II</u><br>IDENTIFY a representative set of plant evolutions to be analyzed, including refueling outages, other controlled shutdowns, and forced outages.<br>See Note POS-N-3 |
| 1.4 | POS-B1    | Omitting the condition to ensure that the POS grouping does not impact risk-significant event sequences could significantly impact the results and insights from the PRA. As such, a new requirement is needed for CCI to reflect as much.  | Qualification | <u>CC-I</u><br>GROUP plant evolutions into a set of representative evolutions.<br>ENSURE that<br>(a) the evolutions within a group can be considered similar in terms of the set of plant operating states that they contain;<br>(b) the evolutions are bounded by the worst case impact within the group;<br>(c) the grouping does not impact risk-significant event sequences.                           |

## Group 2 - External Hazard Risk

| #   | Index No. | Issue  | Position      | Resolution   |
|-----|-----------|--|---------------|--|
| 2.1 | SFR-C1    | Justification of the selected basis needs to be provided, especially for cases where the basis in an extension or expansion of available information. Note S-N-27 also mentions “plant-specific justification” which is not reflected in the SR.   | Clarification | SPECIFY the basis for screening of inherently rugged components justifying the applicability to the plant and site or range of sites identified in SHA-A1.   |
| 2.2 | SFR-C2    | Justification of the selected basis needs to be provided, especially for cases where the basis in an extension or expansion of available information. This comment is also supported by the discussion in Note S-N-28.   | Clarification | SPECIFY the basis and methodologies established for achieving the fragility thresholds defined in Requirement SPR-B5 justifying the applicability to the plant and site or range of sites identified in SHA-A1.  |
| 2.3 | HS-A3     | The requirement does not address plant-specific hazards, which may not be identified as part of the identification of site-specific or design-specific hazards or hazard groups. Additionally, note HS-N-5 appears to be applicable to HS-A3 as it directly relates to plant-specific hazards and hazard groups. | Clarification | IDENTIFY site-, plant-, or <del>and</del> design-specific <del>unique</del> hazards and hazard groups, as applicable to the stage of the plant lifecycle, not already identified in Requirement HS-A2.<br><br>See Notes HS-N3, HS-N-4, HS-N-5.   |
| 2.4 | WHA-A5    | 150 mile distance is arbitrary   | Clarification | ...<br><br>a. meet SCR-3 in Table 1.10-1 by showing that the site <del>is more than 150 miles (approximately 250 km)</del> is sufficiently far away from the nearest tropical cyclone-prone coast to screen out tropical cyclone (hurricane or typhoon) high wind hazards from the probabilistic wind hazard analysis; |

## Group 2 - External Hazard Risk (continued)

|     | Index No. | Issue   | Position      | Resolution   |
|-----|-----------|---|---------------|--|
| 2.5 | SHA-B5    | SHA-B5 does not include consideration of (1) the use of an existing probabilistic SHA for a site and, (2) the impact of an updated catalog on the use of the existing probabilistic SHA. Given the likelihood of using an existing site as the bounding site (see SHA-A1), the considerations identified above are warranted.   | Qualification | Add the following to SHA-B5:<br><br>If an existing probabilistic SHA is used, DEMONSTRATE that an updated catalog of earthquakes does not make the existing probabilistic SHA unviable.  |
| 2.6 | HS-B5     | The values in RI-A5 referenced in item (f) are presented as reporting values, not screening values. Using the reporting values as screening values could be too permissive in excluding contributors from the PRA as screening using a consequence criterion may not be effectively equivalent to screening using a frequency criterion. Additionally, this requirement is effectively for qualitative screening, as per SCR-3 in Table 1.10-1 and because item (f) is a quantitative criterion, it should therefore not be included in the list. | Qualification | USE SCR-3 in Table 1.10-1 when qualitatively screening out a hazard or hazard group by showing that either:<br>(a) the hazard or hazard group cannot physically impact the plant or plant operations (e.g., it cannot occur close enough to the plant to affect it);<br>(b) the hazard or hazard group does not result in a plant trip (manual or automatic) or require a plant shutdown;<br>(c) the hazard or hazard group is included in the definition of another hazard;<br>(d) the hazard or hazard group could not result in worse effects to the plant as another hazard that has a significantly higher frequency;<br>(e) the hazard or hazard group is slow in developing and there is demonstrably sufficient time to eliminate the source of the threat or to provide an adequate response;<br><del>(f) the hazard or hazard group cannot produce a consequence above the value set in RI-A5.</del> |

## Group 3 - Errors of Commission

| #   | Index No. | Issue   | Position      | Resolution   |
|-----|-----------|---|---------------|--|
| 3.1 | HLR-HR-E  | The scope of high-level requirement (HLR) HR-E does not include errors of commission. See HR-E4 in this table for more details about the basis for this issue.  | Qualification | A systematic review of relevant available procedures, any past operational events, procedural guidance, and training shall be used to identify the set of post-initiator operator responses required for each of the event sequences, as well as, the well-intended post-initiator operator responses that result in adverse safety impacts. |
| 3.2 | HR-E4     | HR-E4 does not include errors of commission (EOC). EOCs should be included in the advanced non-light water reactor (LWR) PRA standard for the following reasons: (1) the significant amount of experience in operating LWRs facilitates a consensus between NRC and industry to exclude EOCs from the LWR Level 1/large, early release frequency (LERF) PRA standard; however, there is very little (if any) advanced non-LWR operating experience to allow the consensus to exclude EOCs from the advanced non-LWR PRA standard; (2) it is expected that advanced non-LWRs would rely less on human actions than LWRs, which implies that EOCs would play a more important role in advanced non-LWR PRAs than in LWR Level 1/LERF PRAs; and (3) given that (a) the scope of the advanced non-LWR PRA standard covers what in the LWR world is known as Level 2 PRA and (b) there is no consensus about EOCs in Level 2 PRA, the developers of PRAs for advanced non-LWRs should demonstrate that EOCs are not an issue before eliminating them from consideration. | Qualification | Add the following to item to HR-E4:<br><br>“(c) those well-intended actions performed by control room staff that disable a system, sub-system, or component needed in an event scenario.”  |

## Group 4 - Risk Significance

| #   | Index No. | Issue   | Position      | Resolution   |
|-----|-----------|---|---------------|--|
| 4.1 | RI-N-1    | Proper use of relative and absolute risk significance criteria. | Clarification | <p>Add this text: The choice between using relative or absolute risk significance criteria to develop a PRA should consider issues such as, but not limited to the following:</p> <ul style="list-style-type: none"> <li>• The use of absolute risk significance criteria may yield a limited set of risk-significant items that is insufficient for developing risk insights or verifying the PRA model.</li> <li>• Importance measures traditionally used in LWR PRAs to identify relative risk significant items (e.g., FV and RAW) may be inaccurate or misleading when applied to noncoherent logic models (i.e., logic models that contain NOT logic).</li> <li>• A PRA that is developed using absolute risk significance criteria should be revised if relative risk significance criteria are used to support a subsequent application, and vice versa.</li> </ul> <p>The use of risk significance criteria (relative or absolute) should address the entire set of risk metrics computed by the PRA.</p> |

## Group 5: Reporting Requirements

| #   | Index No. | Issue  | Position      | Resolution   |
|-----|-----------|--|---------------|--|
| 5.1 | RI-N-3    | The staff do not consider reporting requirements when determining the acceptability of a PRA for a given application, such reporting requirements should be provided by the appropriate regulatory authority on an application-specific basis. | Clarification | The reporting requirement in RI-A4 does not need to be met to demonstrate PRA acceptability. |
| 5.2 | RI-N-4    | The staff do not consider reporting requirements when determining the acceptability of a PRA for a given application. Such reporting requirements should be provided by the appropriate regulatory authority on an application-specific basis. | Clarification | The reporting requirement in RI-A5 does not need to be met to demonstrate PRA acceptability. |
| 5.3 | RI-A4     | The staff do not consider reporting requirements when determining the acceptability of a PRA for a given application. Such reporting requirements should be provided by the appropriate regulatory authority on an application-specific basis. | Qualification | This requirement does not need to be met to demonstrate PRA acceptability.                   |
| 5.4 | RI-A5     | The staff do not consider reporting requirements when determining the acceptability of a PRA for a given application. Such reporting requirements should be provided by the appropriate regulatory authority on an application-specific basis. | Qualification | This requirement does not need to be met to demonstrate PRA acceptability.                   |



# **NEI 20-09**

## **PRA Peer Review Guidance**

- NRC staff received NEI 20-09, Rev. 0 on June 1, 2020
- Staff reviewed and provided observations during a public meeting on July 22, 2020
- Staff received a revision to NEI 20-09 on August 24, 2020
- Staff provided additional comments during a public meeting on October 26, 2020
- NEI submitted Revision 1 of NEI 20-09 on May 5, 2021

# NEI 20-09

## PRA Peer Review Guidance

- NEI 20-09, Rev. 1, is based on a related industry PRA peer review guidance document, NEI 17-07, Rev. 2, “Performance of PRA Peer Reviews Using the ASME/ANS PRA Standard,” as endorsed by RG 1.200, Rev. 3
- NEI 20-09 addresses all radiological sources, all hazards, all POSs, and all levels of PRA analysis
- NEI 20-09 process is applicable for a peer review performed for a PRA representing any stage of plant lifecycle
- The staff finds that the guidance in NEI 20-09, Rev. 1, is acceptable and thus endorses NEI 20-09, Rev. 1, without exception, in RG 1.247, Section C.2.2
- The ASME/ANS NLWR PRA standard contains requirements for the performance of an acceptable peer review process. The staff reviewed the requirements and takes no exceptions to them

## NEI 20-09 Pilots

- NEI plans to pilot the peer review process
- Staff to observe the pilots
- Observations will enhance the staff's positions in RG 1.247

# NLWR PRA Acceptability Issues (1 of 3)

- Ten issues were identified as a result of stakeholder feedback on the draft staff white paper “Demonstrating the Acceptability of Probabilistic Risk Assessment Results Used to Support Advanced Non-Light Water Reactor Plant Licensing:”
  - Draft staff white paper: ML21015A434 dated 1/19/2021
  - Public meeting held 2/23/2021
    - Staff presentation: ML21050A240
    - Industry presentation: ML21055A732
    - Meeting summary: ML21069A123 dated 3/17/2021
  - Public meeting held 3/30/2021
    - Staff presentation: ML21085A594
    - Meeting summary: ML21096A107 dated 4/15/2021
- Issue resolution status:
  - Addressed in RG 1.247, or
  - Being addressed in other staff guidance, or
  - Initiating research and developmental activities

# NLWR PRA Acceptability Issues (2 of 3)

| No. | Issue   | Resolution  |
|-----|---|---|
| 1   | Provide guidance on initial licensing that addresses all NLWRs (LMP or not LMP)   | LMP-based applications: <ul style="list-style-type: none"> <li>• NEI 21-07 (industry TICAP guidance)</li> <li>• Trial use RG to endorse NEI 21-07</li> <li>• ARCAP roadmap ISG</li> <li>• ARCAP-related ISGs on specific topics</li> </ul> Non-LMP-based Applications: deferred |
| 2   | Provide guidance on graded PRA approaches   | Working group formed to explore alternatives to PRA that achieve the same underlying purposes   |
| 3   | Provide guidance on voluntary risk-informed applications (in addition to LMP) that may be part of an initial license application or after the license has been issued | NRR/RES work request  |
| 4   | Address the use of risk surrogates  | Addressed in RG 1.247   |
| 5   | Address the use of seismic margins analysis (SMA)   | <ul style="list-style-type: none"> <li>• SMA excluded in NLWR PRA standard and, hence, not addressed in RG 1.247</li> <li>• Applicants who seek to use SMA are encouraged to discuss during pre-application interactions</li> </ul>   |

# NLWR PRA Acceptability Issues (3 of 3)

| No. | Issue  | Resolution   |
|-----|--|--|
| 6   | Address completeness uncertainty   | <ul style="list-style-type: none"><li>• LPSD fires: NRR/RES work request</li><li>• Uncertainty: NRR/RES work request</li></ul> |
| 7   | Define the bounding site for external hazards and radiological consequence evaluation      | Each applicant to propose and justify on a case-by-case basis  |
| 8   | Address the applicability of supporting requirements (SRs) during various licensing stages | Develop ISG  |
| 9   | Address the use of absolute and relative risk significance criteria                        | Addressed in RG 1.247  |
| 10  | Use of peer reviews (full-scope and focused-scope) to demonstrate PRA acceptability        | Addressed in RG 1.247  |

# Risk Significance (1 of 3)

- Goal: Identify what is important
- Uses:
  - Develop the PRA model
    - Increase level of detail and plant representation for risk significant items
    - Logic model debugging
    - Iterative process
  - Report PRA results
- Two approaches:
  - Relative risk significance
    - Normalized to total risk
    - Traditional PRA approach
  - Absolute risk significance
    - Normalized to a specified risk target (e.g., LMP frequency-consequence target curve, QHOs)
    - Concept evolved as a result of various LMP pilot exercises

# Risk Significance (2 of 3)

| Risk Significant Basic Event |  |
|------------------------------|--|
| Relative                     | A basic event that contributes significantly to baseline risk. It is defined as any basic event that has an Fussell-Vesely (FV) importance greater than 0.005 or a risk achievement worth (RAW) importance greater than 2 where the importance is normalized against the baseline total integrated risk or risk of a specific combination of source of radioactive material, hazard, and plant operating state.  |
| Absolute                     | A basic event that contributes significantly to an absolute risk significance criterion selected for RIDM. It is defined as any basic event that contributes significantly to an absolute risk significance criterion selected for RIDM. It is defined as any basic event that<br>a) contributes at least 1% to any identified absolute risk target; or<br>b) would result in exceeding the criterion if the basic event is assumed to fail with probability of 1.0. |



# Risk Significance (3 of 3)

| Risk Significant Event Sequence or Event Sequence Family |   |
|--|---|
| Relative   | An event sequence or event sequence family that, when rank-ordered by decreasing frequency, contributes a specified percentage of the baseline risk, or that individually contributes more than a specified percentage of the risk. For this version of the Standard, the aggregate percentage for the set is 95%, and the individual event sequence or event sequence family percentage is 1% of the total integrated risk or risk of a specific combination of source of radioactive material, hazard, and plant operating state. |
| Absolute   | An event sequence or event sequence family included in a PRA model, defined at the functional or systematic level, that makes a significant contribution to an absolute risk target selected for RIDM. It is defined as any event sequence or event sequence family that contributes at least 1% to any identified absolute risk target.  |



# PERSONAL COMMENTS ON RG 1.247

Karl N. Fleming

Former Chair JCNRM WG on Advanced non-LWRs  
(Currently Vice Chair)

[karlfleming@comcast.net](mailto:karlfleming@comcast.net)

## MY PERSONAL COMMENTS

The following comments are my personal opinions and do not reflect the official position of the JCNRM or supporting groups and subcommittees

# BACKGROUND

- Per NRC request JCNRM prioritized the schedule for this standard ahead of next edition LWR PRA standard
- JCNRM appreciates extensive involvement of NRC staff and NRC contractors in producing the standard and support of Ballot Reviews
- First consideration ballot in May 2020 yielded over 1300 comments including nearly 500 from NRC staff
- Second consideration ballot in July 2020 was unanimously approved by the JCNRM with 86 largely editorial comments mostly from the NRC
- Final editorial changes approved by JCNRM via two unanimous voice votes
- Standard approved by ASME and ANS boards, no comments in public review and final approval by ANSI
- Changes were made to the next edition of LWR standard recently balloted to minimize editorial inconsistencies.
- Given that background I was surprised that the approach taken to express clarifications in the RG was expressed in terms of so many further editorial changes rather than commentary regarding HOW the NRC staff expects the requirements to be addressed for regulatory applications.

# GENERAL COMMENTS

- There are several places that claim that “...risk characterization for NLWRs is typically expressed by cumulative risk metrics or risk surrogates”.
  - These statements should be modified to clarify that fundamental metrics used to formulate the requirements characterize risk in terms of the **frequencies and radiological consequences of event sequence families (not individual sequences)**.
  - The NLWR standard does not use the LWR risk metrics CDF or LERF as explained in Section 1.9.1 so not clear why it is suggested as a possibility in the RG.
  - The PRA standard does not support the use of surrogate risk metrics as a means of expressing the results of the PRA but only as intermediate states for developing the event sequence model. If such intermediate metrics are used, the standard still expects that risk integration and evaluation of risk significance will be based on quantification of frequencies and consequences.
- Sections C.1.3 and C.1.4 provide a long discussion of objectives and attributes for each of the technical elements in the standard. These discussions overlap extensively with material in the standard that cover the same ground but they are not one for one and it would take a long time to figure out if there is anything different here. Rather than paraphrasing material on objectives and attributes already covered in the standard, the RG should focus on the specific items that the staff wishes to clarify
- Many of the clarifications in Appendix A refer to language shared with LWR supporting standards
- In the clarifications provided in Appendix A, it would be helpful for the staff to point out which changes are for alignment with LWR standard vs. those **unique to the NLWR standard**

## SPECIFIC COMMENTS

- Suggestion that “PRA technical adequacy” are the same as “PRA acceptability” needs clarification; “technical adequacy” is based on meeting requirements in an international consensus PRA standard while acceptability expresses a U.S. regulatory position.
- The PRA technical elements presented in Table 1 are not consistent with the ones used in the standard (See Table 1.4-1). The elements listed for internal events are applicable to all internal and external hazard groups. This is one of a number of examples where the RG is paraphrasing material in the standard but in a manner that is not always accurate.
- Should be clarified that the technical requirements for peer review are actually part of the standard and not separate entities as suggested in Figure 1 (Triangle Figure).
- Discussion on POS, MST, and other elements seem to lack appreciation of the need to address the impact of multiple reactors and sources.
- The RG treats documentation in one section whereas standard has documentation requirements specialized for each technical element
- Regarding the staff position on reporting requirements RI-A4(low frequency item) and RI-A5(low consequence item), which defer to specific applications, the authors of the standard believe these are fundamental to recognizing limitations in PRA technology.
- My colleague Dennis Henneke has additional general and specific comments to offer

## PLANS FOR NEXT REVISION

- Per JCNRM guidance, need to wait until all the supporting LWR standards are revised for consistency with the recently balloted LWR Level 1/LERF Standard
  - Low Power Shutdown Standard
  - Level 2 Standard
  - Level 3 Standard
  - Advanced LWR Standard
- Advanced non-LWR community needs to gain sufficient experience using the 2021 edition of the NLWR standard to identify the issues unique to NLWRs and to justify application of standard writing resources.
- Schedule for next revision is undefined

# Review of Draft RG 1.247 Appendix A – NRC Position on ASME/ANA RA-S-1.4-2021

Dennis Henneke  
Consulting Engineer – GE Hitachi  
JCNRM ANS Chair\*

\* Not representing ANS or the JCNRM for this presentation.



## Overview of ASME/ANS PRA Standard Requirements

- The Joint Committee on Nuclear Risk Management (JCNRM) develops and maintains PRA standards for LWRs and NLWRs using a consensus committee made up of all stakeholders including the NRC and its contractors.
  - The NRC provided hundreds of comments on RA-S-1.4-2021, the vast majority were accepted.
- PRA Standards for existing LWRs (draft 2021) and NLWRs (RA-S-1.4-2021) define the following to determine a technically acceptable PRA:
  - **Scope:** This includes the hazards (internal events, internal hazards and external hazards) and the plant operational states (full power, low power and shutdown) for each hazard.
  - **PRA Attributes:** as defined by the High Level Requirements (HLRs) and Supporting Requirements (SRs). HLRs are in the form of Shall statements and SRs support the HLRs. Content of HLRs and SRs are prescribed by the ASME and ANS guidance.
- The PRA standard SRs define what is required (performance-based) to meet the HLRs but should not describe “how to” meet the requirement or limit the approach to a single methodology by referencing a document in an SR.
  - The NRC and JCNRM members have provided numerous comments on removing wording from the SRs that were too much “how to” perform the PRAs.

# Feedback on NRC Clarifications

- The standard has undergone numerous rounds of review including in 2020, and the resulting standard is a consensus product. Many of the NRC clarifications have either gone through consensus review or should go through consensus review for determination of technical correctness:
  - POS-A8: the addition of requiring review of POSs identification by “operations personnel” prior to plant operations (in design) – when we will not necessarily have operations personnel.
  - POS-A10: The clarification requires POS definitions to include changes in “barriers,” “propagation pathways” and modification of fragilities” in the POS definitions.
    - This both disagrees with the definition of POS and is too much “how to” in the SR.
    - Changes such as this are addressed in the PRA modeling, not POS definition.
  - POS-A1 and Note POS-N-2: Clarification is requiring LPSD to be included at “All stages of the Licensing Process”.
    - Disagrees with the discussion throughout the standard and the consensus wording of POS-A1.
    - The standard is not a licensing document and should not discuss what is required at various stages of licensing.

# Feedback on NRC Clarifications

- HLR-HR-E; Added words to the HLR: A systematic review shall be used to identify post-initiator operator responses... *“as well as, the well-intended post-initiator operator responses that result in adverse safety impacts”*
  - Too much “how to” in the HLR.
  - When combined with changes to HR-E4 (*actions that disable a system...*); the changes now require additional analysis of errors of commission, not currently required by any PRA standard.
- HR-D4: Adds reference to NUREG-0700 for *“adherence to human factors guidelines”*
  - Again, too much “how to.”
  - Additionally, reference to a specific document in the SR is not appropriate, since this indicates only one acceptable approach to meet the SR.
- HR-G1: Adds to the requirement wording to *“ASSESS the feasibility of the HFE....; ASSIGN an HEP of 1.0...”* if not feasible.
  - Again, too much “how to.”
  - HRA techniques already include a feasibility step during the qualitative portion of the HRA.
  - A similar change was rejected by the JCNRM previously for the above reasons.
- HR-G4: Adds the wording: *“in supporting the decision, diagnosis, decision-making and action execution given the plant-specific and event scenario-specific context...communication among personnel in the same team and in different teams.”*
  - Again, too much “how to”

# Feedback on NRC Clarifications

- JCNRM standard are not perfect, and we welcome feedback and improvements through the consensus process.
  - Generally, we try to accommodate most comments through change in the standard wording.
  - Some of the NRC exceptions were changes incorporated into the LWR draft in publication (no objection to these).
  - RG 1.247 exceptions do not point to any significant gaps in the NLWR standard.
- The previous examples above are just a few examples where the draft RG should be improved (see backup slide for more examples):
  - Overall, these types of changes should be submitted to the JCNRM NLWR working group for review and consideration to ensure the standard SRs are correctly worded and supported by consensus review.
  - Any NRC recommended changes to the standard wording should be consistent with standard development guidance:
    - Wording should focus on what is required versus how to perform the PRA.
    - HLRs and SRs should not reference specific documents or limit the approach to one approach.
  - The standard should not dictate what scope is required at different phases of licensing.

# DWH Backup

- Other NRC clarifications which should be reviewed:
  - HR-G14 (to much “how to” shown in blue), HR-H2, DA-C20, FLEV-C1 (1<sup>st</sup> mention of temp. alignments – under documentation), SHA-B5, SHA-D3, SFR-C1, C2, SFR-D5 (no other mention of pathways), SFR-E3, E4, E5, E7 (wording is too limiting), HLR-SPR-B, SPR-B6 (expands the relay chatter from Risk-Significant SSCs to all SSCs), SPR-D6 (see previous feasibility comment), SPR-E8 (“and/or” not appropriate), HS-A3 (hazards are not “applicable” to a design stage), HS-B5 (change should be reviewed by JCNRM in brown), WFR-I1 (fix the bullet numbers), WPR-D11 (see previous feasibility comment), XFPR-E6, OPR-A4, OPR-C6 (feasibility), RCRE-A2, RCPA-A3, RCPA-A10, RCME-A2/4/7/8 (also refers to RG 1.23), RCME-A3, RCAD-A5, RCAD-B2, C1, RCDO-A and A1/6 (skin absorption not previously mentioned in the standard), RCDO-A8, RCQ-A3, RCQ-B3 (“results of interest” inaccurate).
- Notes not reviewed for this presentation.

# **Next Steps and Stakeholder Engagement**

Donna Williams, NRR

# Next Steps

- Consider feedback from ACRS/other stakeholders (September – mid-October)
- Public meeting October 20, 2021
- NRC concurrence and trial use RG publication - October – November
- Issue for trial use – December 2021
- Initial use by near-term applicants
- Trial use period is flexible, depending on timing of the next version of standard, rulemakings, and feedback from early use

# Comments and Feedback

- Comments and improvements on all published RGs including this trial use RG are encouraged at any time and the NRC will ensure consideration of such comments and suggestions.
- Preliminary trial use RG made public – September 7, 2021
- October 20, 2021- public meeting
- Trial Use RG published in FRN. FRN includes information on submitting comments.
- Public meetings/workshops to discuss feedback from first uses



# Acronyms

- ANLWR - advanced non-light water reactor
- ANS - American Nuclear Society
- ASME - American Society of Mechanical Engineers
- CFR – *Code of Federal Regulations*
- COL - combined license
- CP - construction permit
- DC - design certification
- ISG - interim staff guidance
- JCNRM - Joint Committee on Nuclear Risk Management
- LMP - licensing modernization project
- LPSD - low-power and shutdown
- LWR - light-water reactor
- NEI - Nuclear Energy Institute
- NRC - Nuclear Regulatory Commission
- NRR - Office of Nuclear Reactor Regulation
- OGC - Office of the General Counsel
- OL - operating license
- QHO – quantitative health objective
- POS – plant operating state
- PRA – probabilistic risk assessment
- RES - Office of Nuclear Regulatory Research
- RG - regulatory guide
- SC - subcommittee
- SSC – structures, systems and components
- SP - staff position
- SR - supporting requirement
- SSC - structure, system, and component

# General Framework for PRA Acceptability

