



10 CFR 50.69 Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors

Mihaela Biro, Reliability and Risk Analyst

Stephen Dinsmore, Senior Reliability and Risk Analyst

PRA Licensing Branch A, Division of Risk Assessment, NRR

NEI Lessons-Learned Workshop, January 30 - 31, 2019



Chronology



2002

South Texas
Project Proof
of Concept

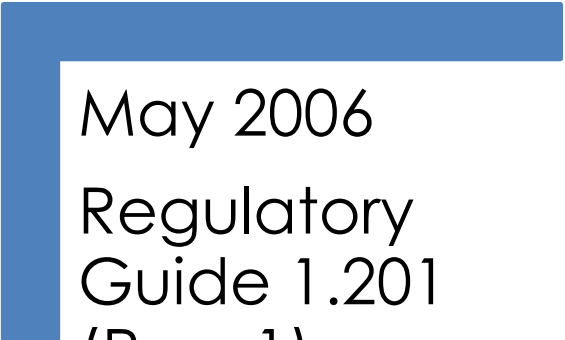
Nov 2004

Promulgate
10 CFR 50.69

July 2005

NEI 00-04
50.69 SSC
Categorization
Guideline

Chronology (Continued)



May 2006
Regulatory
Guide 1.201
(Rev. 1)



August 2012
Vogtle Pilot
LAR

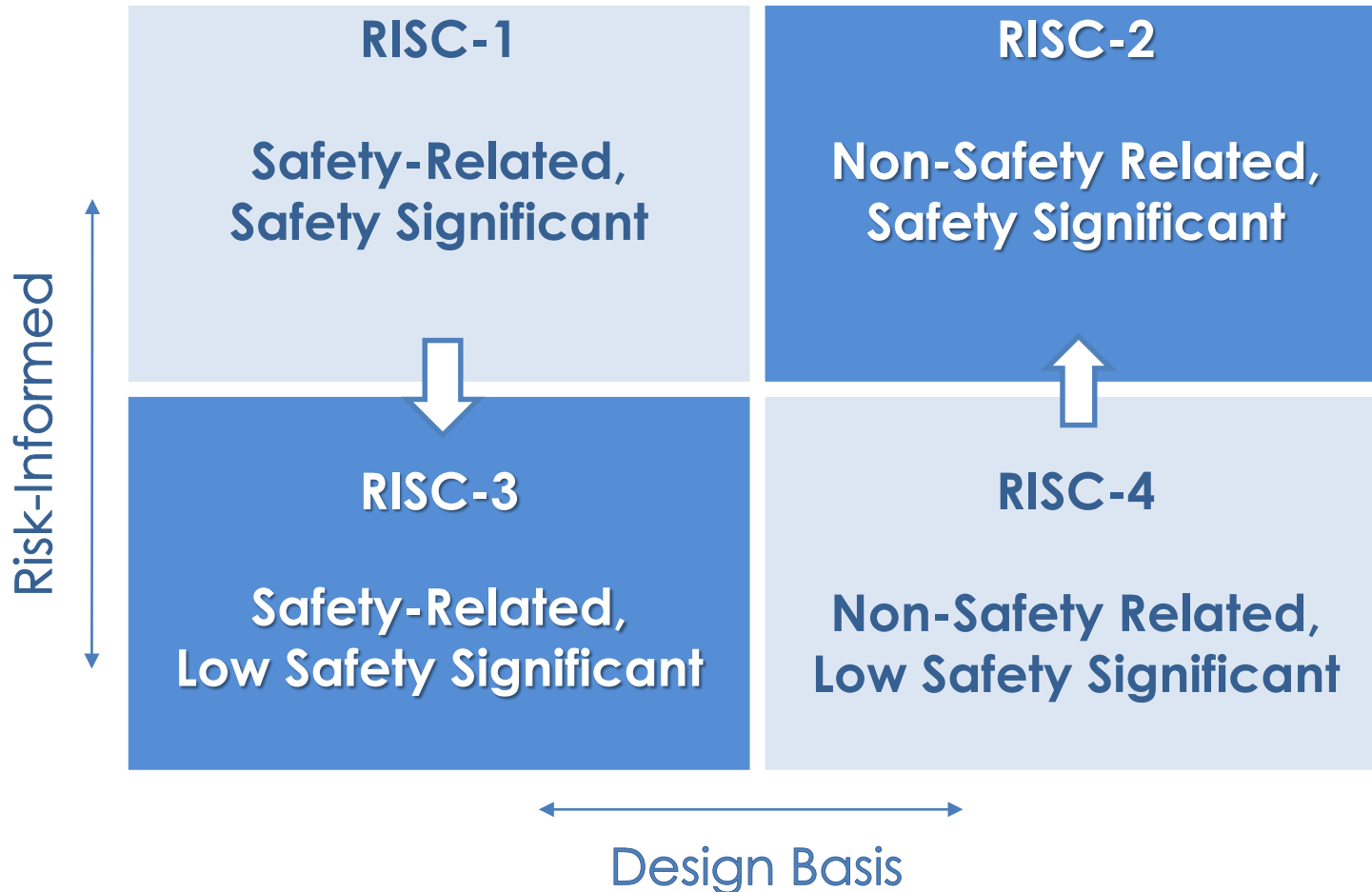


Dec 2014
NRC SER on
Pilot LAR

10 CFR 50.69 Overview

- Voluntary alternative risk-informed rule
- Determine safety significance of SSCs based on NRC approved risk-informed categorization process
- Modify special treatment requirements for safety-related SSCs of low safety significance
- Must be performed for entire system(s)

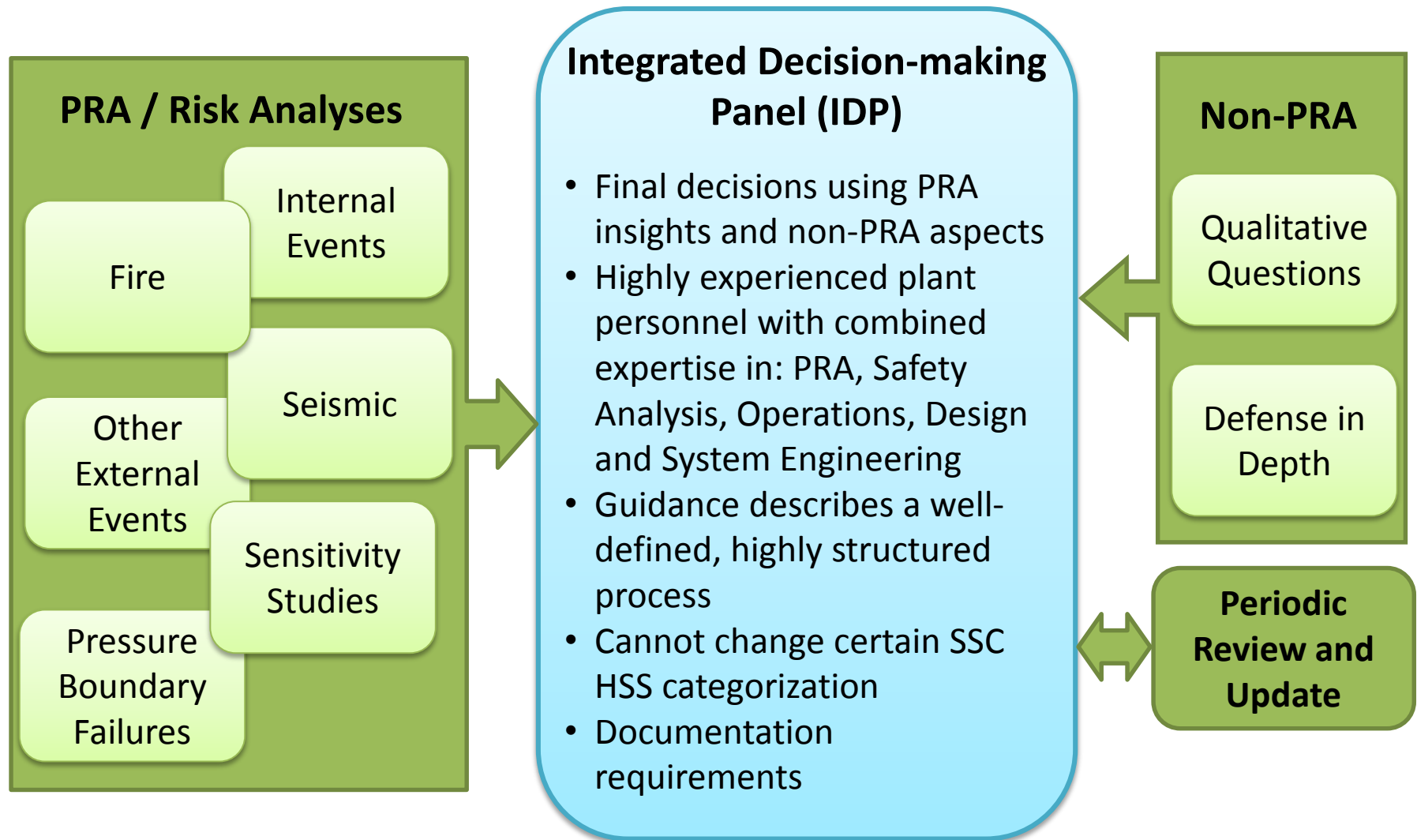
10 CFR 50.69 Categorization



Special Treatment Can Be Modified for Low Safety Significant SSCs

- Reporting (10 CFR Part 21)
- Quality assurance (10 CFR 50 Appendix B)
- Environmental qualification (10 CFR 50.49)
- Certain containment leakage testing requirements (10 CFR 50 Appendix J)
- Seismic qualification (10 CFR 100 App A)
- Maintenance rule (10 CFR 50.65)

Robust Categorization Process



NRC Staff LAR Review Scope

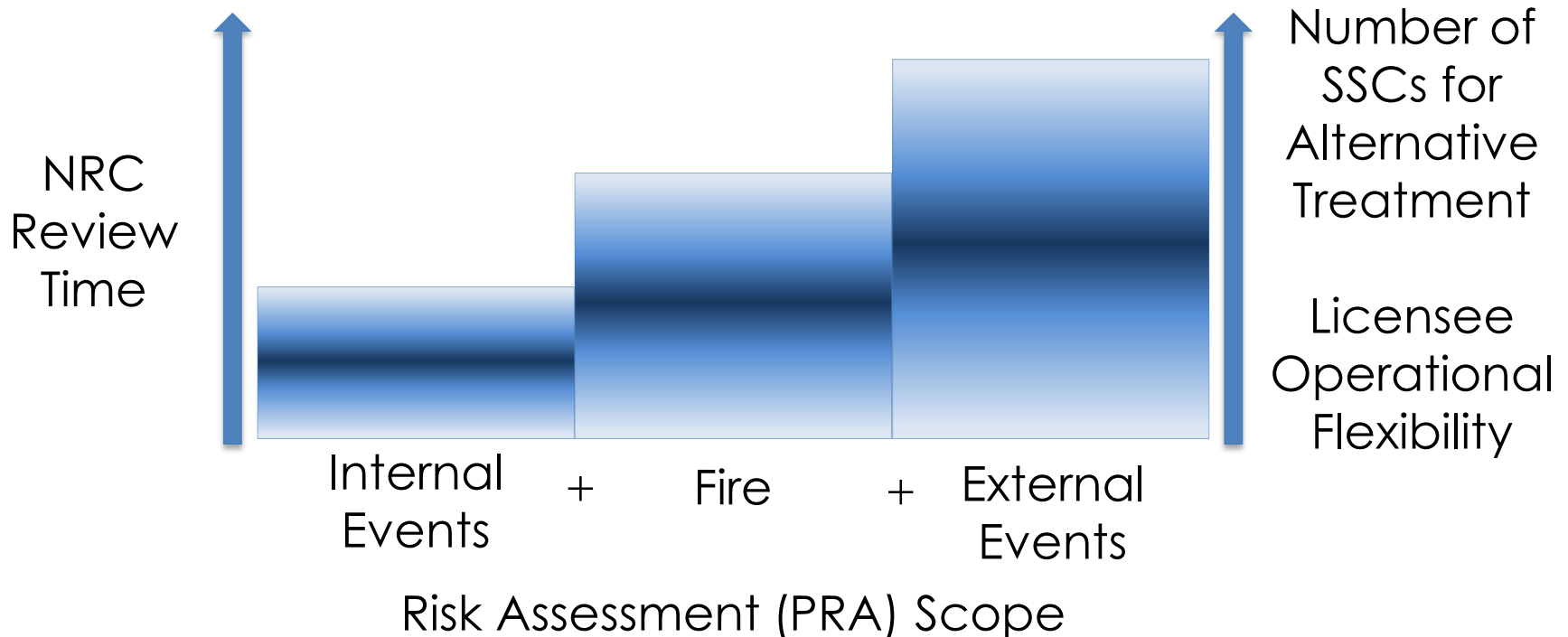
- ✓ Technical acceptability of PRA models (e.g. internal events, fire, seismic)
 - Review of peer review findings and disposition
 - PRA assumptions and sources of uncertainty
- ✓ External events treatment without PRA
- ✓ Categorization process
- ✗ Categorization results and alternative treatment not reviewed during LAR review; subject to inspection.

Setting the Stage for Effective Staff Review

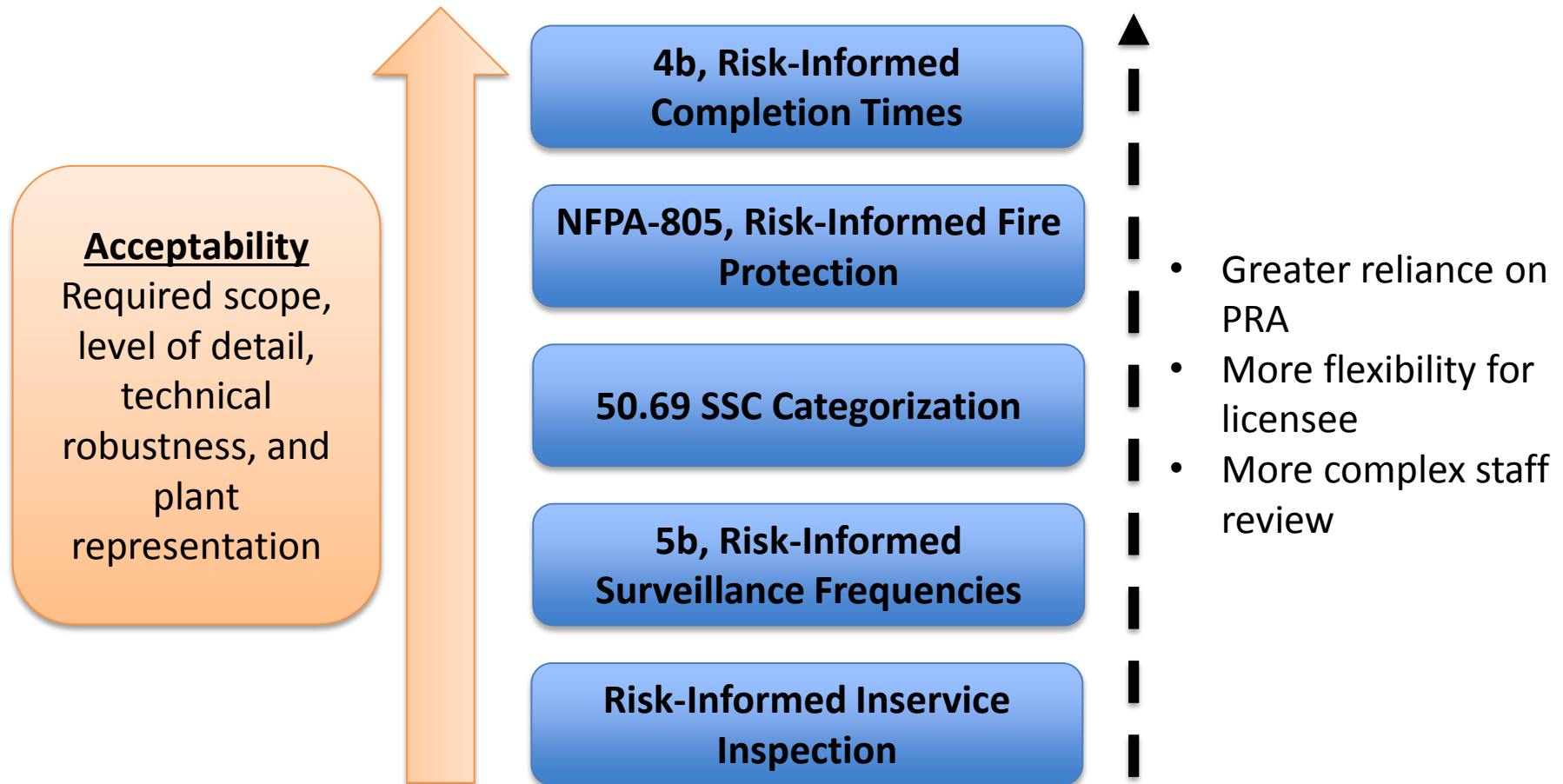
- Well established regulatory basis by rule
- Endorsed guidance: NEI 00-04, RG 1.201
- Pilot completed 3 years prior to new applications
- LAR Template; industry pre-review
- NRC acceptance reviews
- Early identification of deviations

50.69 Review Effort Commensurate with Scope of the PRA

- Review heavily impacted by PRA acceptability
- LARs of increased PRA scope require more NRC review hours but afford increased flexibility



Level of PRA Acceptability Depends on the Application



Challenges to Effective NRC Review of PRA Acceptability

- Outdated PRA peer reviews using older guidance
- Complex sequence of gap assessment(s) and focused scope peer review(s)
- Incomplete list of F&Os or associated dispositions
- Outdated F&Os
- PRA upgrades not identified or not peer reviewed
- F&O closure not following NRC accepted process
- Ongoing PRA changes performed during the NRC review (e.g.: parallel risk-informed applications for NFPA-805 and 50.69; not addressing implementation items from previously approved LARs)

NRC Acceptance Review Process LIC-109

- **Goals of the acceptance review process** are to:
 - facilitate submittal of acceptable LARs
 - reduce unnecessary review delays
 - efficiently use review resources
- **LAR is found acceptable for review if** the application
 - contains scope and depth of necessary technical information
 - can support NRC staff's completion of detailed technical review in appropriate time frame

NRC Acceptance Review Process Increases Review Efficiency

- **Example items that resulted in non accept with opportunity to supplement determination:**
 - Incomplete or outdated peer reviews
 - Unclear scope of peer reviews
 - Unclear scope of PRA
 - F&O closure conducted prior to the May 3, 2017 NRC acceptance
 - Incomplete or no dispositions for multiple F&Os or uncertainties
 - No description of key assumptions and sources of uncertainties
 - Lack of sufficient safety justification for deviations from guidance or approved precedent

Categorization Process Review

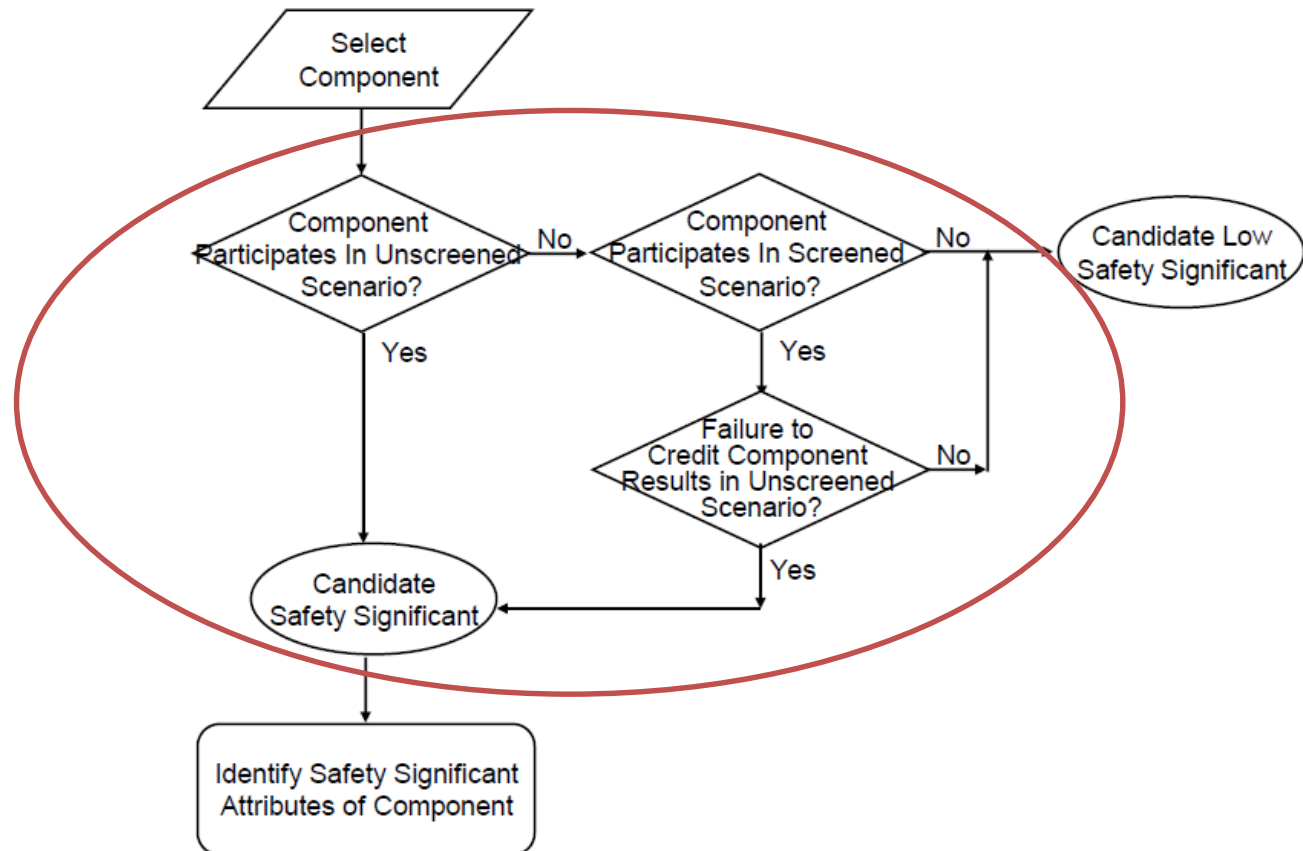
- **Lack of detail slowed down review**
 - First few LARs after pilot did not describe process, stated that guidance in NEI 00-04 will be followed
 - Process was first reviewed for the pilot Vogtle application
 - Staff found certain aspects of the guidance could be open to interpretations
- Initial audits reviewed categorization process, sampled categorization results and observed a mock IDP
- RAI requested a summary of the process
 - Describe order of process, what categorization can be changed by IDP, how the IDP will use qualitative questions
- ✓ **RAI response incorporated into later LAR template; facilitates expedited review**

LAR Deviations Lead to Inefficient Review

- **Deviations from guidance or approved precedent slow down reviews**
- Example: categorization of pressure-retaining items
 - Many LARs requested applying passive component methodology to Class 1 pressure retaining items
 - Pilot approved it for Class 2 and 3
 - Staff requested additional justification because
 - Class 1 SSCs constitute principal fission product barrier
 - Consequence of pressure boundary failure for Class 1 SSCs may be different than for Class 2 and Class 3
 - Had the potential to slow down all 50.69 reviews
- ✓ **Request withdrawn by industry which facilitated timely completion of many LARs**

Treatment of Other External Hazards

- NEI 00-04 has specific guidance of treatment of other external hazards, Figure 5-6



Treatment of Other External Hazards

- **LARs generally silent on addressing NEI 00-04, Figure 5-6 guidance**; state that other external hazards (e.g. high winds, external flooding, etc.) were screened from applicability; LARs provide summary of screening results
- RAs requested licensee to:
 - Justify screening for each hazard; LAR summary sometimes was unclear
 - Identify and justify any SSCs credited for screening
 - Confirm NEI 00-04 Figure 5-6 will be applied
 - i.e. SSCs would be HSS, if screened scenario(s) would become unscreened
- ✓ **Addressing issues upfront in LAR expedites review**

Addressing Known Common Issues Upfront Expedites Staff Review

Examples:

- **PRA credit for FLEX** address May 30, 2017 memo (ML17031A269)
- **PRA credit for Westinghouse RCP Shutdown Seals** consistent with NRC safety evaluation for PWROG-14001-P, Revision 1 (ML17200A116)
- **Process for reviewing key assumptions and sources of uncertainty** consistent with NUREG-1855
- **Other external hazards treatment** consistent with NEI 00-04 guidance
- **Categorization process** consistent with NEI 00-04 guidance and approved precedents

Audits Improve Review Efficiency

- Audits support improved staff understanding, more effective RAIs and safety evaluations
- On site, or virtual with electronic portal and teleconference
- 50.69 Audits:
 - Early audits verified categorization process
 - Observed mock IDP
 - Electronic audits of F&O Closure reports
 - Virtual audits for later reviews

PRA Acceptability to Support Effective Staff Review

- PRA readiness heavily impacts review schedule
- Stable PRA at time of submittal improves efficiency
 - Current peer reviews following accepted peer review guidance
 - Use of Independent Assessment F&O closure consistent with NRC accepted process
- Complete dispositions of open F&Os and key sources of uncertainty
 - Justify why there is no impact on the categorization, or
 - Commit to fix the PRA, or
 - Describe and justify sensitivity studies to be performed during categorization (NEI 00-04, Section 5)

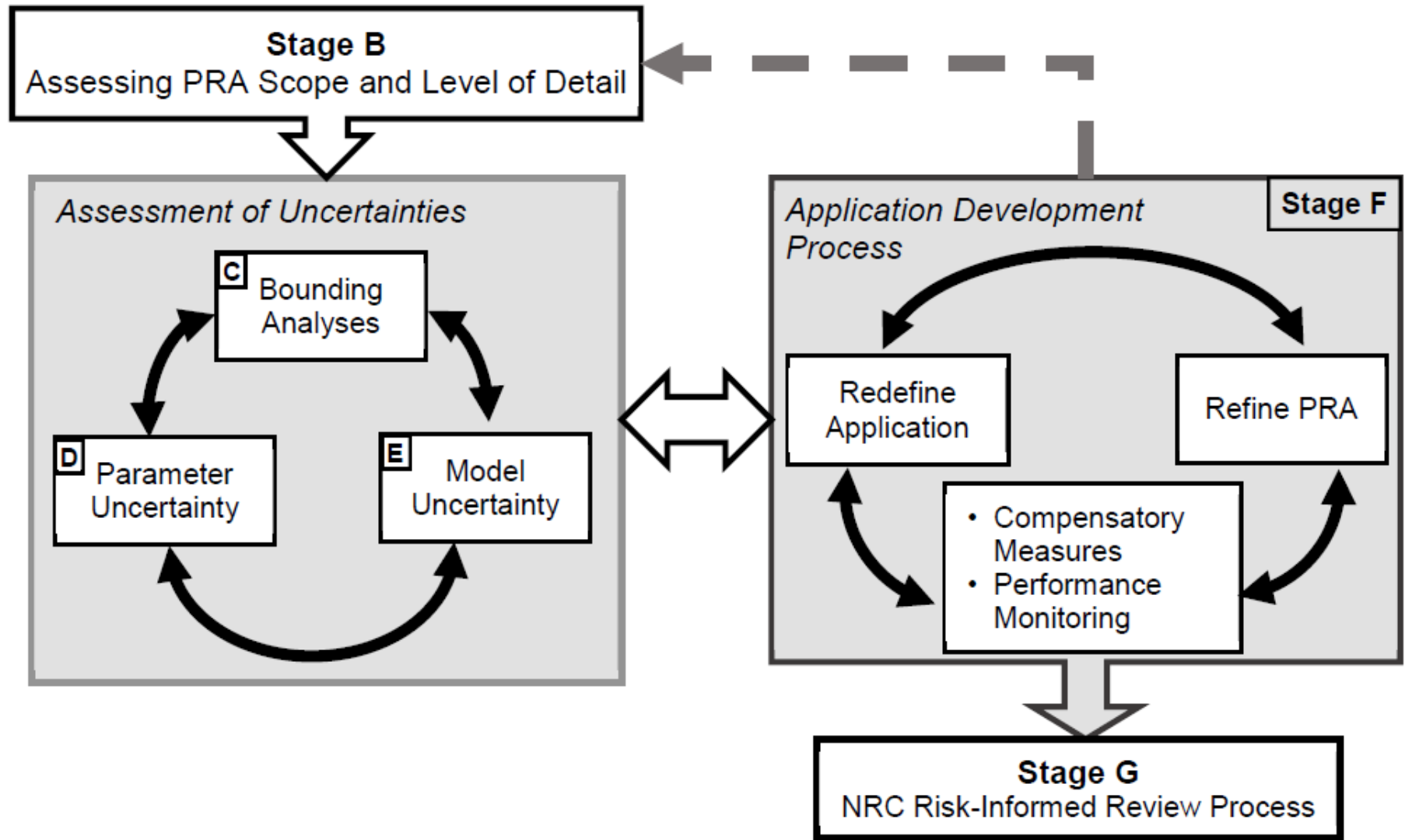
Key Assumptions and Sources of Uncertainty Guidance

- RG 1.200, Determining PRA Technical Adequacy
 - Staff review focused on key assumptions and F&Os
 - NUREG-1855 provides guidance on identifying and evaluating key assumptions
- NEI 00-04, 10 CFR 50.69 SSC Categorization Guidelines
 - SSCs categorized through a series of steps, ending with an aggregate risk increase assessment
 - Includes “applicable sensitivity studies” for each PRA, as needed
- RG 1.201 endorses NEI 00-04
 - Key assumptions identified via peer reviews or self assessment
 - Address the impact of key assumptions on the categorization through the “applicable sensitivity studies”

Key Assumptions and Sources of Uncertainty Guidance NUREG-1855

- List of generic assumptions
 - EPRI TR-1016737 (internal events)
 - EPRI TR-1026511 (fire, external events)
- Each assumption evaluated to determine if a different reasonable alternative assumption would produce different results (i.e., Key assumption)
- Three options after impact of key assumption known
 - redefine the application, or
 - refine the Probabilistic Risk Assessment, or
 - use compensatory measures or performance monitoring requirements.
- Challenges encountered with these evaluations

All Stages of NUREG-1855 Need to Be Addressed





Observations on Consideration of External Hazards Risk in 50.69

Mehdi Reisi-Fard, Team Leader
Shilp Vasavada, Reliability and Risk Analyst

Risk Informed Licensing Initiatives Team, DRA, NRR

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Discussion Topics

- Technical acceptability of external hazards PRAs
 - Addressing staff comments on NEI 12-13
 - Addressing internal events F&Os
 - Differences between Addenda A and B of ASME/ANS PRA Standard for SPRAs
- Use of external hazards PRAs for categorization
 - Calculations of importance measures
 - “Mapping” of components in external hazard PRAs
 - Key assumptions and sources of uncertainty
 - Performance monitoring
- Proposed alternative seismic approach

Addressing Staff Comments on NEI 12-13

- Staff accepted NEI 12-13 (ADAMS ML18025C025) with clarifications and exceptions including
 - Identification of review of “newly developed methods”
 - Qualifications of the peer review team
 - Use of UAMs
 - Use of expert judgement
 - Review of any supporting requirement against CC I
 - Performing “in-process” peer review (i.e., separate peer review for each external hazard technical element)
- Beneficial to include explicit discussion of consideration of staff comments during performance of the peer-review

Addressing Internal Events PRA F&Os

- External hazards PRAs are usually built using the IEPRA as the base
- Important to ensure acceptability of IEPRA used as the base for external hazards PRAs
 - Finding may not impact certain applications of IEPRA model, but may impact external hazards
 - Resolutions may not have been propagated to external hazards PRAs
 - Resolution of finding in IEPRA may be different from what was propagated to other PRAs at time of development
- Beneficial to have explicit consideration of IEPRA acceptability in self-assessment as well as peer review for external hazards PRAs

Use of Addendum B in Licensing Applications

- Staff endorsed EPRI report 1025287, known as SPID, for use in developing SPRAs to respond to the 10 CFR 50.54(f) letter
- SPID cites Part 5 of 2013 version of ASME/ANS PRA Standard (Addendum B)
 - Peer reviews of seismic PRAs performed against Addendum B
 - Addendum B has not been endorsed for use in licensing activities
- “Gap” assessment of differences between SPRA SRs in Addenda A and B needed (example: ADAMS ML17192A245)
- Staff accepted Code Case to Part 5 of Addendum B with comments (ADAMS ML18017A964)

Calculation of Importance Measures

- Calculation of importance measures from external hazard PRAs is not as straightforward as that for internal events:
 - Discretize the hazard curve into 'bins' for quantification purposes
 - Include hazard-specific failure modes for components in addition to random failures
- Staff approved approaches submitted in recent LARs to calculate F-V and RAW from external hazard PRAs (example: ADAMS ML18180A062)

Mapping of Components

- External hazard PRAs include SSCs and failure modes that may not be modeled in other PRA models
- SSCs or failure modes can be mapped to components that are modeled (e.g. considered as part of the 'super-component' boundary)
- If SSCs are determined to be HSS from the external hazard PRAs and mapping cannot be performed
 - Integrated importance measure may be determined, or
 - SSC can conservatively assumed to be HSS and presented as such to the IDP for categorization.

Key Assumptions and Sources of Uncertainty

- RG 1.200: “the applicant identifies the key assumptions [...] relevant to that application. This will be used to identify sensitivity studies...”
- An effective approach for identification and disposition of key assumptions and sources of uncertainty includes
 - Compilation all assumptions used across technical elements (i.e., hazard, fragility, and plant response)
 - Use of RG 1.200 definition and NUREG-1855 guidance to identify key assumptions and sources of uncertainty
 - Disposition of the identified key assumptions using qualitative or quantitative (i.e., sensitivity studies) means on an application-specific basis

Performance Monitoring

- 10 CFR 50.69(e) requires performance monitoring and 'feedback loop'
- 'Risk Sensitivity Study' in NEI 00-04 guidance used to evaluate the risk implications of changes in special treatment
 - Consideration of external hazard (e.g., seismically-induced) failure modes not explicitly addressed in guidance
 - Factor of 3 to 5 increase in unreliability due to change in special treatment is not considered applicable to such failure modes based on existing information

Performance Monitoring (Cont'd)

- Existing or enhanced programs and processes along with PRA configuration control should demonstrate the 'feedback loop'
 - Programs and processes unaffected by categorization
 - Design change control process with enhancement for seismic impact assessment, aging management, and degradation monitoring
 - PRA configuration control expected to capture potential degradations during life of the program
- Above examples of performance monitoring are applicable after categorization

Proposed Alternative Seismic Approach

- Subset of plants do not have SPRA or SMA
- Industry proposed an alternative approach
 - Three-tiered approach for plants with low, medium and high seismic hazard/margin
 - Seismic insights from four sensitivity studies used to claim that most seismic risk significant SSCs are identified by internal events and/or fire PRAs
- NRC has discussed technical issues in public meetings
- A lead plant has recently submitted Tier 1 of the approach;
Second lead plant expected to submit Tier 2 of the approach
- Staff's review is ongoing



Observations on Consideration of External Hazards Risk in 50.69

Ed Miller, Project Manager

Special Projects & Processes Branch, Division of Operating Reactor Licensing, NRR

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Effective and Efficient Reviews

- Reviewing a process not a product
 - Technical staff observation of IDP
- Work with NEI to provide comments on model LAR
- LAR pre-flight screening by NEI
- Interface with NEI to resolve common issues and provide NRC staff feedback during the development of new approaches
- Staggering LARs with deviations from guidance or proposing new approaches
- Allowing pilot reviews to complete before submitting other LARs

LAR Preparation

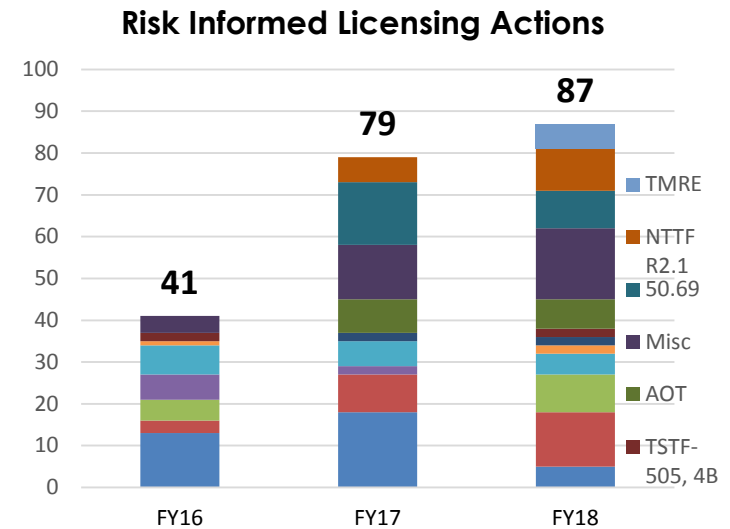
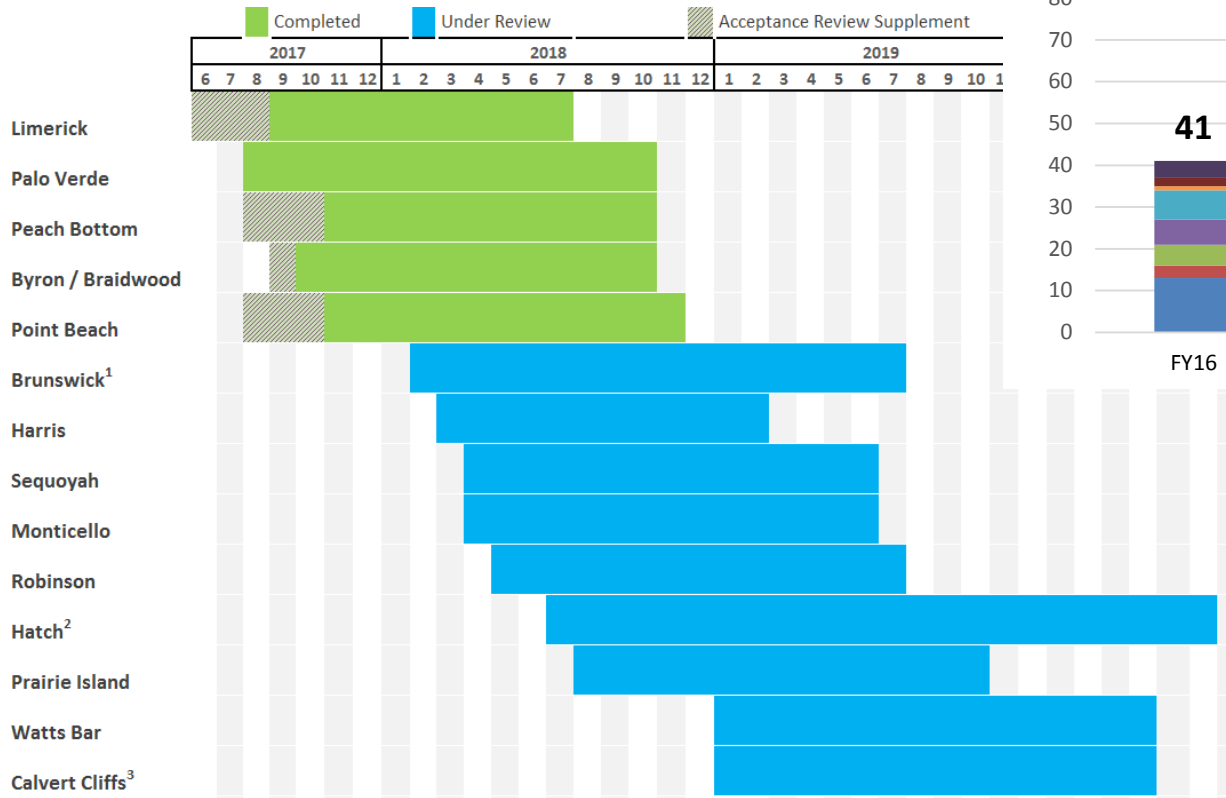
- LAR template facilitates consistency
 - Recognition that one size can't fit all
- Open communication
 - Pre-application meetings
 - Address deviations from, or exceptions to, model LAR
- Industry review prior to submittal
 - Avoiding repeat RAIs
- Submit mature LARs
 - License conditions to resolve issues following approval of the LAR add to review complexity
- Stagger non-standard LARs

LAR Review

- Acceptance review discipline
- Existing tools can be heavily leveraged
 - Information portals
 - Audits
 - Public meetings
- Coordination of reviewers
 - A goal, but not always possible
- Integrated review teams

10 CFR 50.69 Review Status

- 20 applications for 50.69 received
 - 8 completed (includes 2 for Vogtle)
 - 9 under review; 3 withdrawn



¹ High Winds, External Flooding PRA

² Tied to NFPA-805 review

³ Lead plant for new seismic approach

Conclusions

- NRC and stakeholders have established an effective LAR application and review process
- Ongoing coordination and communication with industry is critical to maintaining efficiency
- Minimizing deviations and providing high quality LARs supports review efficiency

Acronyms

- ADAMS – Agencywide Documents Access and Management System
- ANS – American Nuclear Society
- ASME – American Society of Mechanical Engineers
- CC – Capability Category
- F&Os – Facts and Observations (PRA)
- F-V – Fussell-Vesely
- HSS – High Safety Significant
- IDP – Integrated Decision-making Panel
- IEPR – Internal Events PRA
- LAR – License Amendment Request
- LIC-109 – NRC Licensing Procedure for Acceptance Review
- NEI – Nuclear Energy Institute
- NFPA-805
- PRA – Probabilistic Risk Assessment
- RAI – Request for Additional Information
- RAW – Risk Achievement Worth
- RCP – Reactor Coolant Pump
- RG – Regulatory Guide
- RISC – Risk-informed Safety Class
- SER – Safety Evaluation Report
- SSCs – Structures, Systems and Components
- SPID – Screening, Prioritization and Implementation Details, EPRI Report 1025287
- SR – Supporting Requirement
- UAM – Unreviewed Analysis Method