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

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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

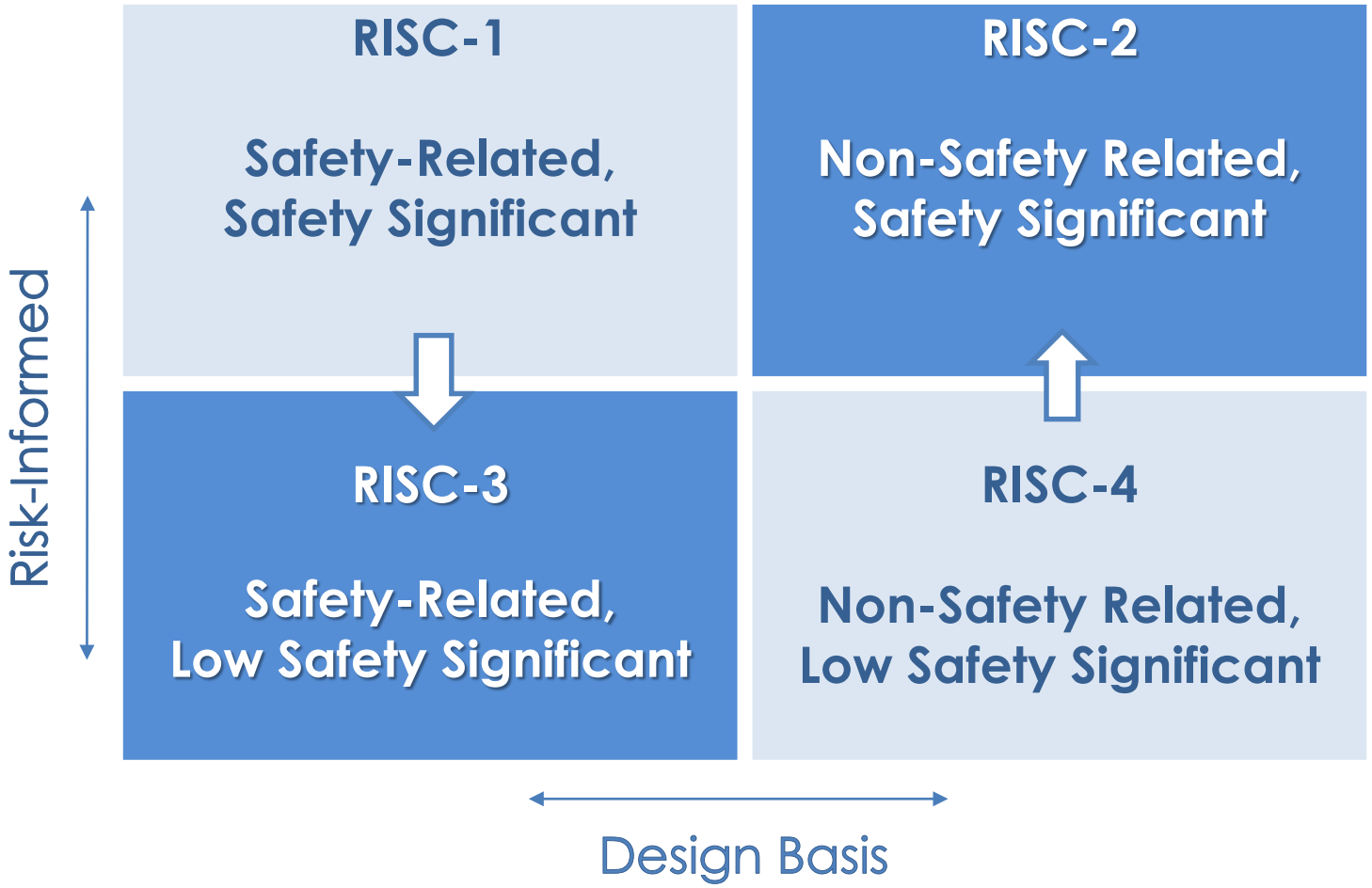
Dec 2014

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)

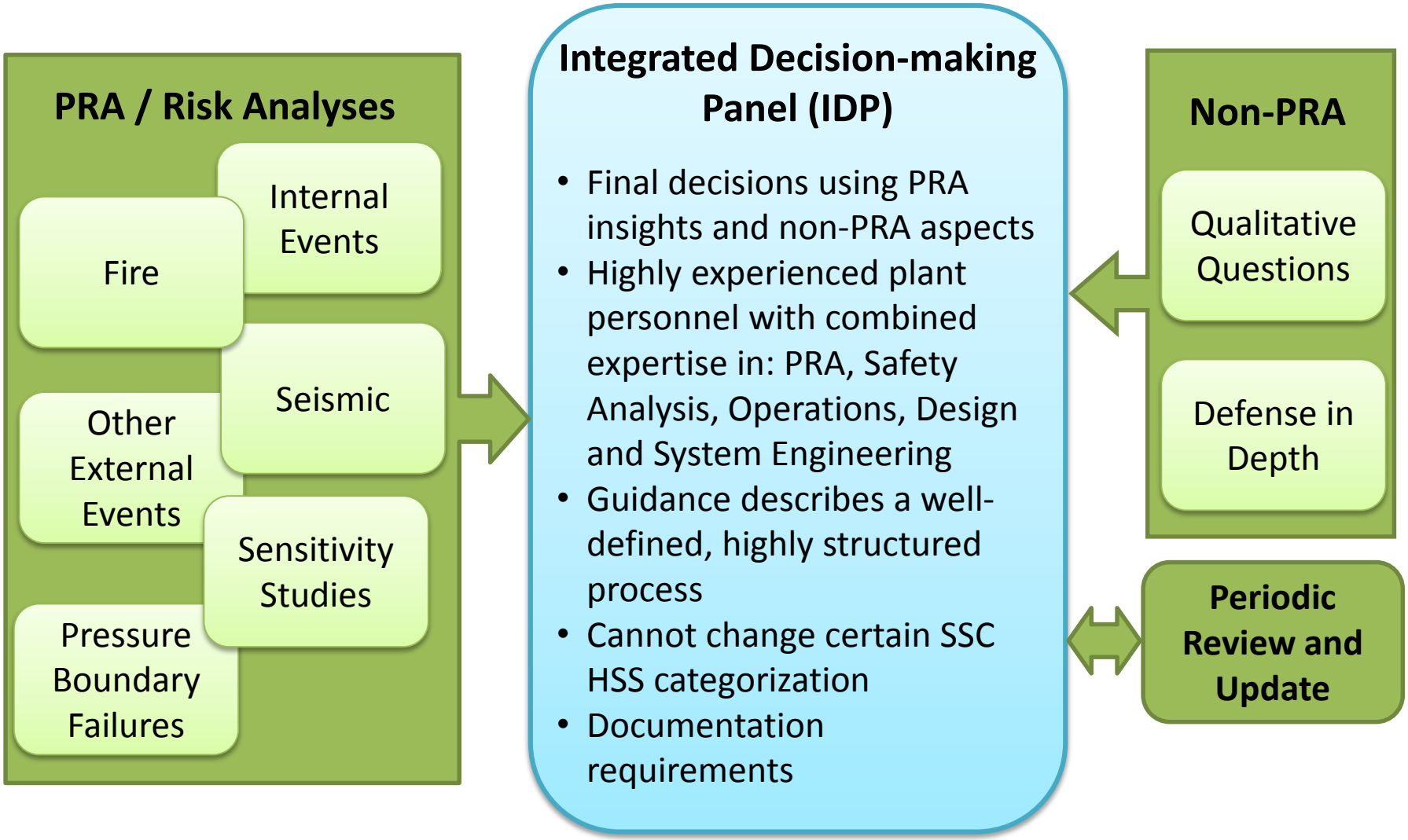
10 CFR 50.69 Categorization



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

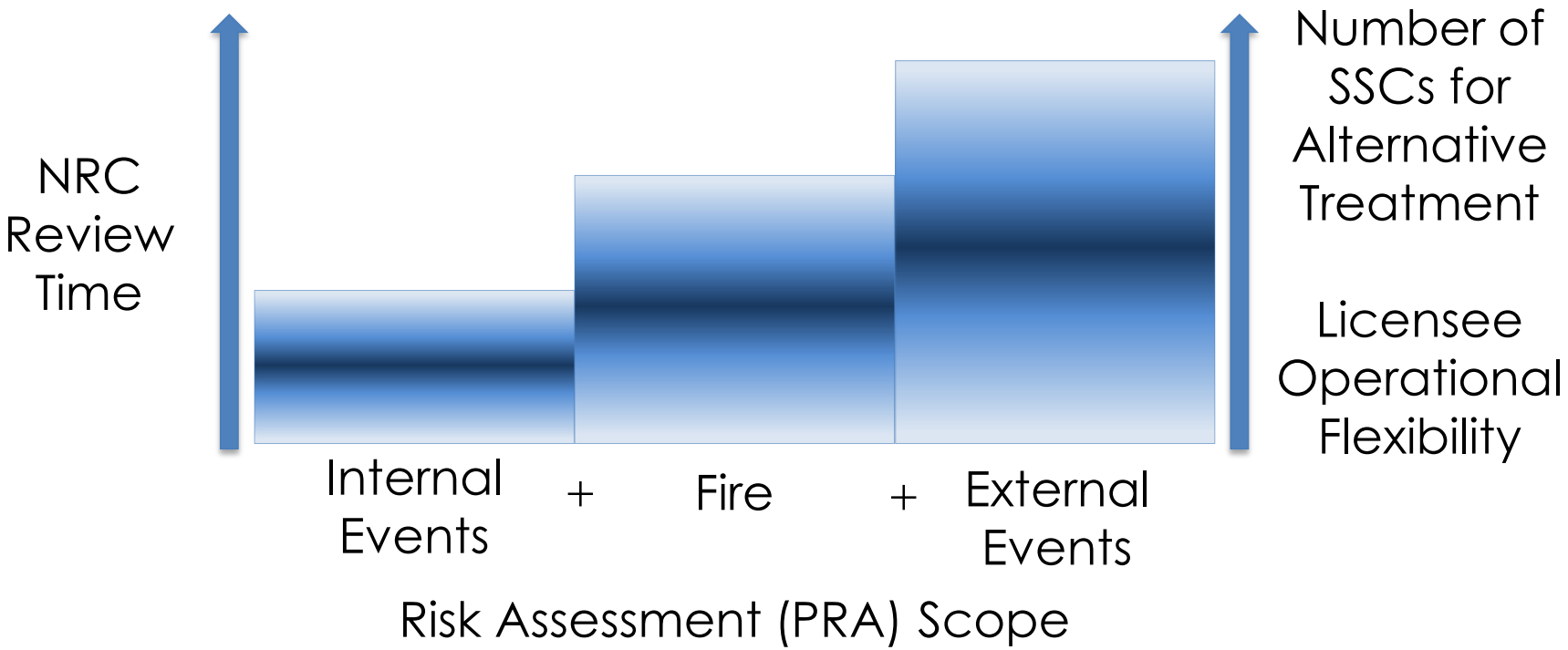
- ✓ Technical acceptability of PRA models (e.g. internal events, fire, seismic)
  - Review of peer review findings and disposition
  - PRA assumptions and sources of uncertainty
- ✓ External events treatment without PRA
- ✓ Categorization process
- ✗ Categorization results and alternative treatment not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

Setting the Stage for Effective Staff Review

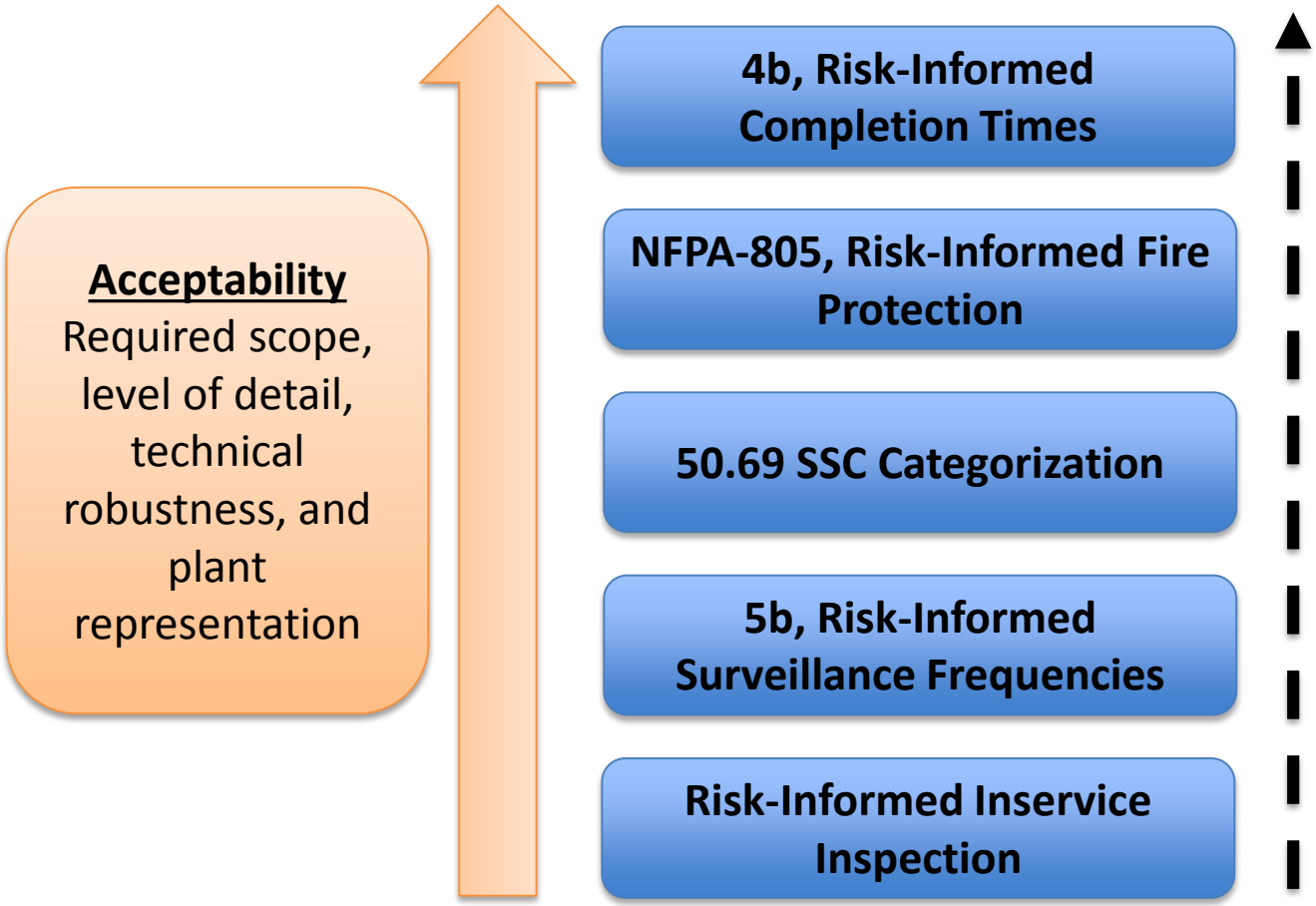
- Well established regulatory basis by rule
- Endorsed guidance: NEI 00-04, RG 1.201
- Pilot completed 3 years prior to new applications
- LAR Template; industry pre-review
- NRC acceptance reviews
- Early identification of deviations

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



- Greater reliance on PRA
- More flexibility for licensee
- More complex staff review

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**

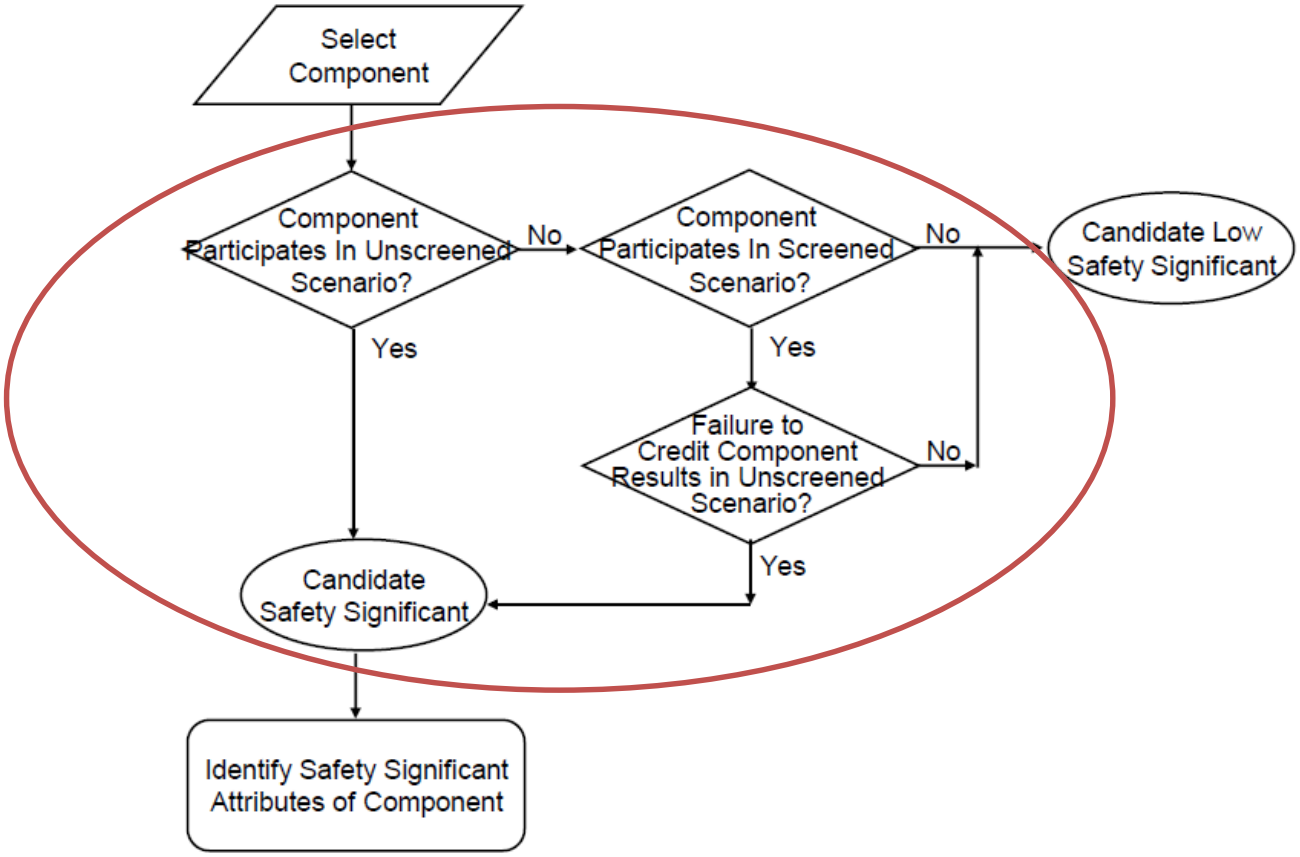
LAR Deviations Lead to Inefficient Review

- **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
- RAIs 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)

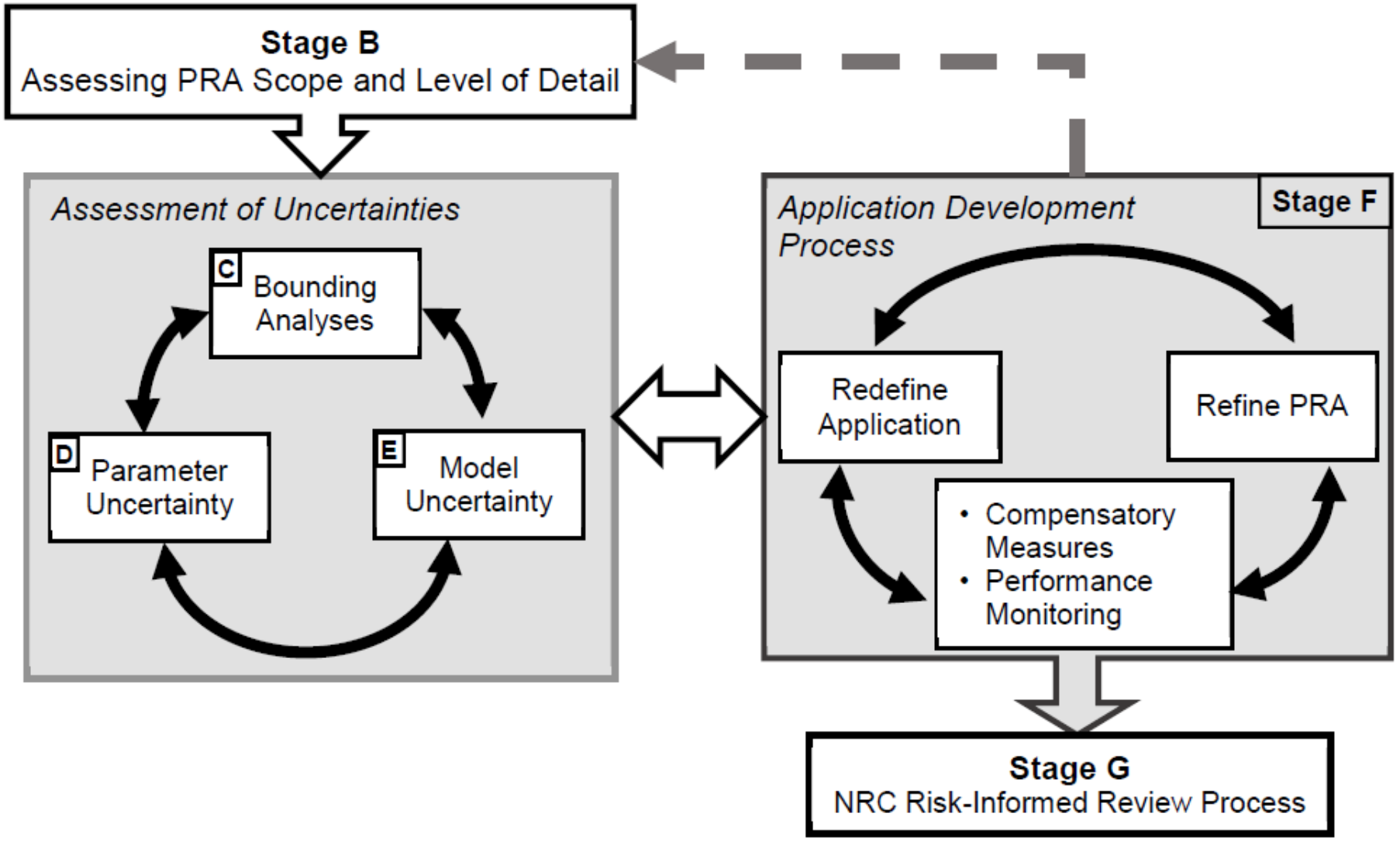
Key Assumptions and Sources of Uncertainty Guidance

- 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 though 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



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Observations on Consideration of External Hazards Risk in 50.69

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

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

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Observations on Consideration of External Hazards Risk in 50.69

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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

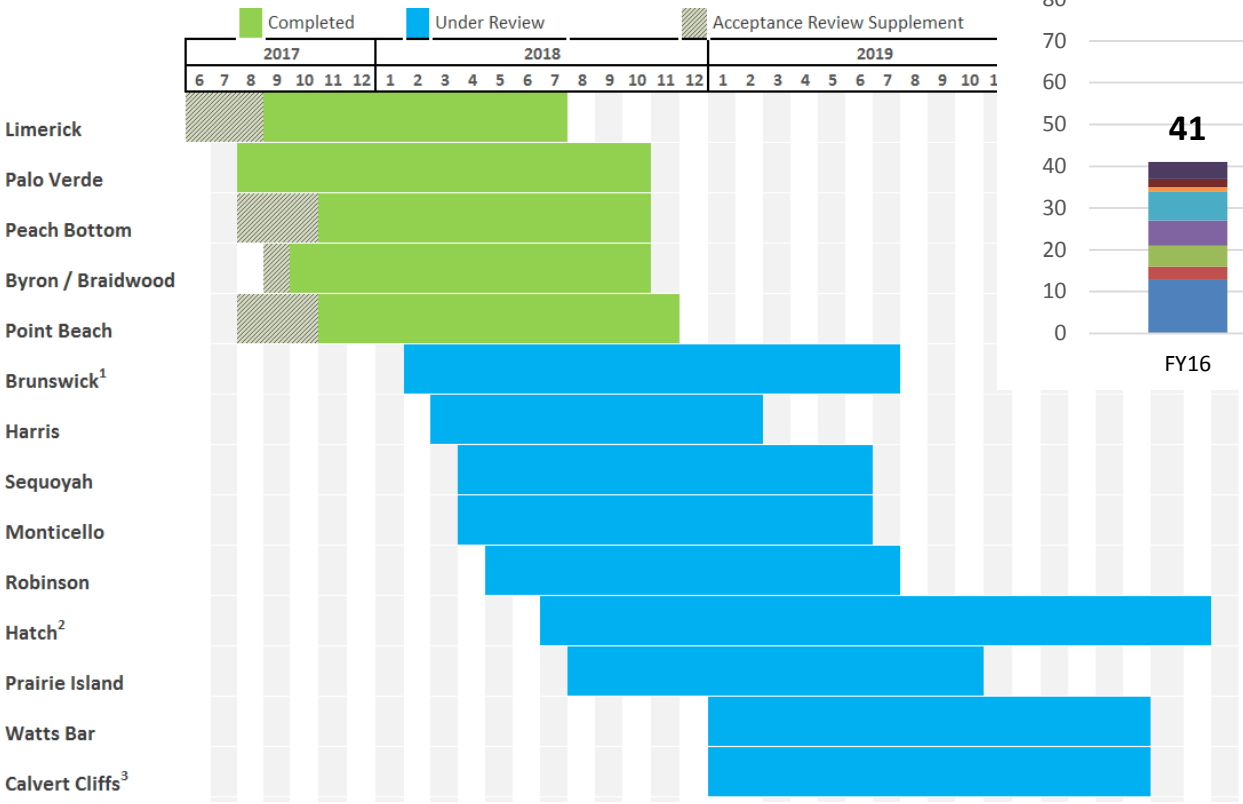
- LAR template facilitates consistency
  - Recognition that one size can't fit all
- Open communication
  - Pre-application meetings
  - Address deviations from, or exceptions to, model LAR
- Industry review prior to submittal
  - Avoiding repeat RAIs
- Submit mature LARs
  - License conditions to resolve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

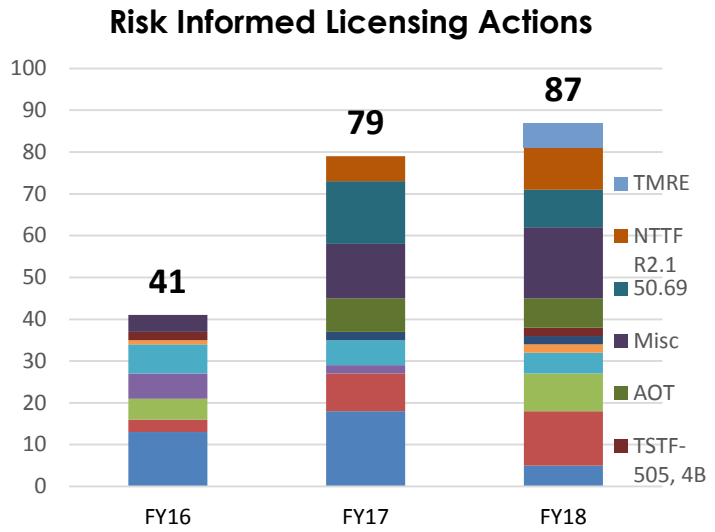
LAR Review

- 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
- IEPRA – 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