

PRA Information to Support Design Certification and Combined License Applications

Division of Safety Systems and Risk Assessment
Office of New Reactors

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RG and SRP Renumbering

Old SRP	New SRP	RG	Topic
n/a	Section 19.0	RG 1.206 - C.I.19 - C.III.1	Combined License Applications for Nuclear Power Plants (LWR Edition) COL applications that are not based on a DC COL applications that are based on a DC (see Chapter 19 for PRAs)
Chapter 19.1	Section 19.1	RG 1.200	PRA technical adequacy
Chapter 19	Section 19.2	RG 1.174	Risk information used to support permanent plant-specific changes to the licensing basis

Finding Information (1 of 3)

- Draft revision to 10 CFR Part 52:
 - Commission approved on April 11, 2007
 - Received final clearance from OMB and awaiting final review from the Office of Administration
 - On the NRC public website:
 - >Nuclear Reactors (pull-down menu)
 - >Reactor Quick Links
 - >NRC Ruleforum (about halfway down, on the left hand side)
 - >Proposed Rules (menu on left side of the screen)
 - >Locate the entry dated 5/22/2007, “Licenses, Certifications, and Approvals for Nuclear Power Plants, (RIN 3150-AG24)”
 - >Draft Final Rule Language

Finding Information (2 of 3)

- Regulatory Guide 1.206
 - Issued on June 20, 2007
 - Available in ADAMS:
 - Section C.I.19 – ML070630023
 - Section C.III.1 – ML070630027 (last two pages)
 - On the NRC public website:
 - >Nuclear Reactors (pull-down menu)
 - >New Reactor Licensing
 - >Combined License (COL) Application Guidance
 - >Regulatory Guide 1.206
 - >Table of Contents (embedded hypertext link)
 - >All sections of RG 1.206 are available here

Finding Information (3 of 3)

- Standard Review Plan (NUREG-0800)
 - Issued on June 20, 2007
 - ADAMS
 - SRP Section 19.0 (initial issuance) - ML071700652
 - SRP Section 19.1, Rev. 2 - ML071700657
 - SRP Section 19.2, Rev. 2 - ML071700658
 - On the NRC public website:
 - >Nuclear Reactors (pull-down menu)
 - >New Reactor Licensing
 - >Standard Review Plan (NUREG-0800)
 - >Chapter 19 – Severe Accidents
 - >Sections 19.0, 19.1, and 19.2 are available here

Applicable Regulations (1 of 3)

- Design Certifications:
 - 10 CFR 52.47(a)(27) - The FSAR must contain "...a description of the design-specific probabilistic risk assessment (PRA) and its results."
- Combined Licenses:
 - 10 CFR 52.79(a)(46) - The FSAR must contain "...a description of the plant-specific probabilistic risk assessment (PRA) and its results."

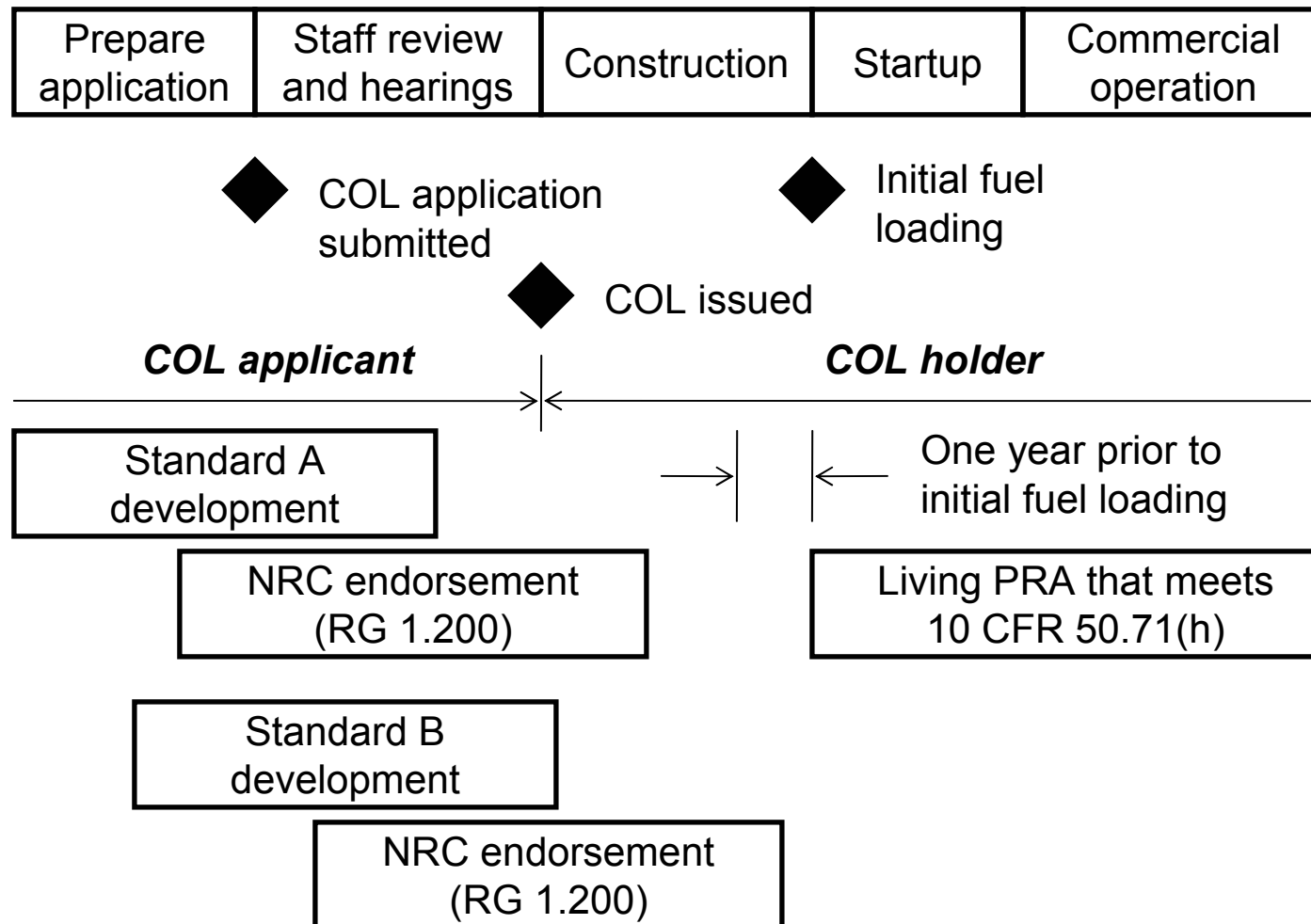
Applicable Regulations (2 of 3)

- If the COL application references a standard design approval, then:
 - 10 CFR 52.79(c)(1) - The plant-specific PRA information must use the PRA information for the design approval and must be updated to account for site-specific design information and any design changes or departures.
- If the COL application references a standard design certification, then:
 - 10 CFR 52.79(d)(1) - The plant-specific PRA information must use the PRA information for the design certification and must be updated to account for site-specific design information and any design changes or departures.
- If the COL application references the use of one or more manufactured nuclear power reactors licensed under subpart F of this part, then:
 - 10 CFR 52.79(e)(1) - The plant-specific PRA information must use the PRA information for the manufactured reactor and must be updated to account for site-specific design information and any design changes or departures.

Applicable Regulations (3 of 3)

- For COL holders: PRA maintenance and upgrading
 - 10 CFR 50.71(h)(1) - No later than the scheduled date for initial loading of fuel, each holder of a combined license under subpart C of 10 CFR part 52 shall develop a level 1 and a level 2 probabilistic risk assessment (PRA). The PRA must cover those initiating events and modes for which NRC-endorsed consensus standards on PRA exist one year prior to the scheduled date for initial loading of fuel.
 - 10 CFR 50.71(h)(2) - Each holder of a combined license shall maintain and upgrade the PRA required by paragraph (h)(1) of this section. The upgraded PRA must cover initiating events and modes of operation contained in NRC-endorsed consensus standards on PRA in effect one year prior to each required upgrade. The PRA must be upgraded every four years until the permanent cessation of operations under § 52.110(a).
 - 10 CFR 50.71(h)(3) - Each holder of a combined license shall, no later than the date on which the licensee submits an application for a renewed license, upgrade the PRA required by (h)(1) to cover all modes and all initiating events.

Timeline



Uses of the PRA

- The applicant's PRA and severe accident evaluation are used as follows:
 - During the design phase to identify and address vulnerabilities, reduce risk contributors, select among design alternatives
 - Identify risk-informed safety insights
 - Demonstrate how risk compares to the Commission's goals
 - Assess the balance between accident prevention and mitigation
 - Demonstrate that the plant design represents a reduction in risk compared to existing operating plants
 - Demonstrate that the design addresses the TMI-related requirements in 10 CFR 50.34(f)
- PRA results and insights are used to support other programs:
 - RTNSS
 - Regulatory oversight processes (MSPI, SDP, TS, MR, etc.)
 - ITAACS, RAP, COL Action Items, etc.

PRA Scope for a COL Application

- Level 1 (core-damage) and Level 2 (containment analysis)
- All initiating events
 - Internal initiators (e.g., transients, LOCAs)
 - External initiators (e.g., seismic, internal fires)
- All operating modes
 - Full-power
 - Low-power and shutdown
- A lack of NRC-endorsed industry consensus standards does not reduce this scope
 - The uses of DC and COL PRAs imply that they need to address all initiators and all operating modes

PRA Level of Detail

- Must reflect the as-to-be-built and as-to-be-operated plant
 - Need to review the DC PRA, and revise as necessary (e.g., site-specific service water system design)
 - Use of bounding analyses is acceptable under certain conditions
 - Identify vulnerabilities, design and operational requirements, ITAACs, COL Action Items
 - Do not mask or distort risk-significant information or risk insights

PRA Technical Adequacy

- RG 1.200 provides one acceptable approach to demonstrating acceptable technical adequacy
- NRC-endorsed industry consensus standards require peer reviews
- The ASME PRA Standard states that users may need to add or revise requirements in the Standard to address advanced LWRs (novel or passive features, digital I&C, etc.)
- Meeting NRC-endorsed industry consensus standards should help expedite the staff's review

Development of Risk Insights

- Design features that are effective in reducing risk
- Significant contributors to risk
- Significant contributors to maintaining plant safety and ensuring that risk does not increase unacceptably
- Significant contributors to uncertainty
- Sensitivity of risk contributors

The Meaning of “Significant”

- Several terms related to “significant” are defined in the ASME PRA Standard, as clarified by Rev.1 to RG 1.200.
 - **Significant accident sequence:** One of the set of accident sequences that, when rank-ordered by decreasing frequency, aggregate to 95% of the CDF, or that individually contribute more than 1% of the CDF.
 - **Significant accident progression sequence:** One of the set of accident sequences that, when rank-ordered by decreasing frequency, aggregate to 95% of the LERF [LRF], or that individually contribute more than 1% of the LERF [LRF].
 - **Significant basic event:** A basic event that has a FV importance greater than 0.005 or a RAW importance greater than 2.
 - **Significant cutset:** One of the set of cutsets that, when rank-ordered by decreasing frequency, aggregate to 95% of the CDF (or LERF), or that individually contribute more than 1% of the CDF (or LERF).

PRA Maintenance and Upgrade (1 of 2)

- COL applicants should describe their PRA maintenance and upgrade programs:
 - A screening process may be used that allows some plant modifications to be deferred or not incorporated, or require immediate PRA maintenance or upgrade
 - Technical adequacy considerations:
 - PRA areas where there are no NRC-endorsed industry consensus standards
 - The conduct of peer reviews and the disposition of findings
 - Corrective action and feedback mechanism

PRA Maintenance and Upgrade (2 of 2)

- The terms “maintenance” and “upgrade” are defined in the ASME PRA Standard, as clarified by Rev.1 to RG 1.200.
 - Maintenance: The update of the PRA models to reflect plant changes such as modifications, procedure changes, or plant performance (data).
 - Upgrade: The incorporation into a PRA model of a new methodology or changes in scope or capability that impact the significant sequences. This could include new human error analysis methodology, new data update methods, new approaches to quantification or truncation, or new treatment of common cause failure.

PRA Documentation

- Information to be included in the FSAR is contained in RG 1.206, Section C.I.19, Appendix A
 - COLs based on a DC may include information by reference (see RG 1.206, Section C.III.1, Chapter 19 for guidance)
- Applicants should maintain archival information per RG 1.200
- NRC staff may seek clarifying information through the RAI process or through audits (documented in a publicly available audits report that can be referenced in the staff's SER)

Format and Content (1 of 10)

- RG 1.206, Section C.I.19, Appendix A (format and content guidance) provides one acceptable definition of the phrase “description of the PRA and its results.”
- Following the format and content guidance should help expedite the staff’s review:
 - All information needed to reach a regulatory decision is provided
 - Standard format (same for each plant type)

Format and Content (2 of 10)

- 19.1 Probabilistic Risk Assessment
 - 19.1.1 Uses and Applications of the PRA
 - 19.1.1.1 Design Phase
 - 19.1.1.2 COL Phase
 - 19.1.1.3 Construction Phase
 - 19.1.1.4 Operational Phase

For the COL, construction, and operational phases, describe:

- Support of Licensee Programs
- Risk-Informed Applications

Format and Content (3 of 10)

- 19.1 PRA (Continued)
 - 19.1.2 PRA Quality
 - 19.1.2.1 PRA Scope
 - 19.1.2.2 PRA Level of Detail
 - 19.1.2.3 Technical Adequacy
 - 19.1.2.4 Maintenance and Upgrade Program

Format and Content (4 of 10)

- 19.1 PRA (Continued)
 - 19.1.3 Special Design/Operational Features
 - 19.1.3.1 Prevention of Core-Damage
 - 19.1.3.2 Mitigation of Core-Damage Mitigation and Prevention of Containment Release
 - 19.1.3.3 Mitigation of Containment Release
 - 19.1.3.4 Use of the PRA in the Design Process

Format and Content (5 of 10)

- 19.1 PRA (Continued)
 - 19.1.4 Safety Insights for Internal Events
 - 19.1.4.1 Level 1 Internal Events
 - 19.1.4.2 Level 2 Internal Events
 - 19.1.4.3 Level 3 Internal Events (optional)
 - 19.1.5 Safety Insights for External Events
 - 19.1.5.1 Seismic Risk Evaluation
 - 19.1.5.2 Internal Fire Risk Evaluation
 - 19.1.5.N Other External Events (add a section for each external event considered)
 - 19.1.6 Safety Insights for Other Modes

Format and Content (6 of 10)

- 19.1 PRA (Continued)
 - 19.1.7 PRA-Related Inputs to Other Programs
 - 19.1.7.1 Design Programs and Processes
 - 19.1.7.2 Maintenance Rule
 - 19.1.7.3 Reactor Oversight Process
 - 19.1.7.4 Reliability Assurance Program
 - 19.1.7.5 RTNSS
 - 19.1.7.N Other Inputs (as appropriate)
 - 19.1.8 Conclusions

Format and Content (7 of 10)

- What is “a description of the PRA?”
 - PRA methodology
 - List of initiating events
 - Success criteria (what they are, how they were determined including T/H codes used)
 - Accident sequences (event tree plots may be helpful)
 - List of plant systems and functions, including dependency matrix
 - Identify the source of all numerical data used
 - PRA software platform
 - PRA truncation limit

Format and Content (8 of 10)

- What are “PRA results?”
 - Risk metrics (CDF, LRF, CCFP)
 - Description of significant sequences and their mean frequencies
 - Significant initiating events and their percent contribution to the overall risk metrics
 - Significant functions, SSCs, operator actions and their FV importance and RAW values
 - PRA assumptions and PRA-based insights
 - Results from sensitivity and uncertainty analyses

Format and Content (9 of 10)

- 19.2 Severe Accident Evaluation
 - 19.2.1 Introduction
 - 19.2.2 Severe Accident Prevention
 - 19.2.3 Severe Accident Mitigation
 - 19.2.4 Containment Performance Capability
 - 19.2.5 Accident Management
 - 19.2.6 Potential Design Improvements Under 10 CFR 50.34(f)

Format and Content (10 of 10)

- 19.3 Open, Confirmatory, and COL Action Items Identified as Unresolved
 - 19.3.1 Open Items
 - 19.3.2 Confirmatory Items
 - 19.3.3 COL Action Items

Frequently Asked Questions (1 of 5)

- FAQ #1: What is meant by a Level 2 PRA?

Answer: The PRA needs to be developed to the point that CDF, LRF, and CCFP can be estimated.

- FAQ #2: Is a Level 3 PRA required?

Answer: No, but applicants may decide to use a Level 3 PRA to evaluate SAMDAs. Appendix A to Section C.I.19 of RG 1.206 provides optional format and content guidelines for a Level 3 PRA.

Frequently Asked Questions (2 of 5)

- FAQ #3: Is the PRA part of the licensing basis?

Answer: The PRA information provided in Chapter 19 of the FSAR is part of the licensing basis, and is subject to two sets of updating requirements:

- FSAR updating
 - 10 CFR 50.71(e)(3)(iii), which applies from the time of docketing until the Commission makes the finding under §52.103(g): annually
 - 10 CFR 50.71(e)(4), which applies thereafter: annually or 6 months after each refueling outage provided the interval between successive updates does not exceed 24 months
- 10 CFR 50.71(h) for PRA maintenance and upgrading: 4 years

Frequently Asked Questions (3 of 5)

- FAQ #4: Does 10 CFR 50, Appendix B apply to the PRA?

Answer: No. However, consistent with the guidance in RG 1.206 (and Section 2.5 of RG 1.174), the applicant should subject its PRA to quality control. The following methods are acceptable to ensure that the pertinent requirements of Appendix B to 10 CFR Part 50 are met:

- Use qualified personnel
- Use procedures that ensure control of documentation, including revisions, and provide for independent review, verification, or checking of calculations and information
- Documentation and maintenance of records, including archival documentation as well as submittal documentation
- Use of procedures that ensure appropriate attention and corrective actions are taken if assumptions, analyses, or information used previously are changed or determined to be in error.

Frequently Asked Questions (4 of 5)

- FAQ #5: Is there a grace period for COL holders to meet a new PRA standard after the staff endorses it?

Answer: 10 CFR 50.71(h) provides a one-year grace period.

Frequently Asked Questions (5 of 5)

- FAQ #6: Is it necessary to perform a seismic PRA or a fire PRA?

Answer: Until industry consensus standards are developed and endorsed by the staff, applicants may use the methods for seismic and fire risk evaluations that have been accepted in previous DC applications.

Once industry consensus standards have been developed and endorsed by the staff, the staff expects that DC applicants, COL applicants, and COL holders will meet the endorsed standards.

Acronyms and Initialisms

- ASME – American Society of Mechanical Engineers
- CCFP – conditional containment failure probability
- CDF – core-damage frequency
- CFR – Code of Federal Regulations
- COL – combined license (issued under 10 CFR Part 52)
- DC – design certification (issued under 10 CFR Part 52)
- FSAR – Final Safety Analysis Report
- HCLPF – high confidence of low probability of failure
- I&C – instrumentation and controls
- ITAAC – inspections, tests, analyses, and acceptance criteria
- LOCA – loss of coolant accident
- LWR – light water reactor
- LRF – large release frequency
- MR – Maintenance Rule (10 CFR 50.65)
- MSPI – mitigating systems performance index
- NRC – Nuclear Regulatory Commission
- PRA – probabilistic risk assessment
- RAP – reliability assurance program
- RG – regulatory guide
- RTNSS – regulatory treatment of non-safety systems
- SAMDA – severe accident mitigation design alternative
- SDP – significance determination process
- SER – safety evaluation report
- SMA – seismic margins analysis
- SRP – Standard Review Plan (NUREG-0800)
- TMI – Three Mile Island
- TS – technical specification