U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

19.1 DETERMINING THE TECHNICAL ADEQUACY OF PROBABILISTIC RISK ASSESSMENT FOR RISK-INFORMED LICENSE AMENDMENT REQUESTS AFTER INITIAL FUEL LOAD

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of probabilistic risk assessment.

Secondary - None

I. AREAS OF REVIEW

Introduction

This Standard Review Plan (SRP) section addresses the technical adequacy of a baseline probabilistic risk assessment (PRA) used by a licensee to support license amendments for an operating reactor, as well as license amendment requests submitted after initial fuel load for new reactors. Technical adequacy, scope, and level of detail are components of overall PRA quality. Regulatory Guide (RG) 1.174 provides guidance regarding all three attributes of PRA quality. Note that the technical adequacy of the PRA used by an applicant to support the design certification (DC) or combined license (COL) application, and by a licensee to support license amendments submitted prior to the initial fuel load is addressed in SRP Section 19.0. In using this SRP section, the reviewer should focus on determining if the baseline PRA reflects the status of the design and the appropriate operational features.

Revision 3 – September 2012

This SRP section defines what constitutes a technically acceptable baseline PRA, which is addressed by RG 1.200. RG 1.200 describes the necessary scope, the technical elements of a PRA, and the technical attributes and characteristics for a full-scope PRA. RG 1.200 allows the use of PRA standards and peer reviews to demonstrate conformance. As such, RG 1.200 also provides the needed attributes and characteristics of a peer review and endorses both American Society of Mechanical Engineers (ASME) and American Nuclear Society (ANS) standards, as well as industry peer review guidance.

Applicability

This SRP section is applicable to any licensee amendment request submitted for U.S. Nuclear Regulatory Commission (NRC) review and approval for which information from a PRA is used to support the requested action. This SRP section will be used to support application-specific SRP sections that provide guidance for activities, including the following examples:

- Changes to a plant's licensing basis (SRP Section 19.2).
- Changes to allowed outage times and surveillance test intervals in plant-specific technical specifications (SRP Section 16.1).
- Changes in the scope and frequency of tests on pumps and valves in a licensee's in-service test program (SRP Section 3.9.7).
- Changes in the scope and frequency of inspections in a licensee's in-service inspection program (SRP Section 3.9.8).
- Implementation of National Fire Protection Association (NFPA) 805 in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Paragraph 50.48(c) (SRP Section 9.5.1.2).

The above SRP sections address reviewing the application in terms of some or all of the following:

- Structures, systems, and components (SSCs); operator actions; and plant operational characteristics affected by the application.
- Cause-effect relationships between the change and the above SSCs, operator actions, and plant operational characteristics.
- Mapping of the cause-effect relationships onto PRA model elements.
- Identification of the PRA results that will be used in the decision making.
- Scope of the PRA needed to support the decision.

The PRA should be of sufficient technical adequacy to support its role in the decision making process. The existing SRP sections only give guidance on assessing the use of the PRA results. RG 1.200 and this SRP Section 19.1 give specific guidance on assessing the adequacy of the baseline PRA.

This SRP section may be used in conjunction with an application-specific SRP section such as SRP Section 19.0, Section 19.2, Section 16.1, Section 3.9.7, Section 3.9.8, or Section 9.5.1.2, which focus on the appropriate use of the PRA results in an integrated decision-making process. This SRP section may also be used to support novel applications in which the licensee is expected to identify how the PRA results are used to provide information to the decision makers.

General

This SRP is intended to support the staff in its assessment of the technical adequacy of the PRA model used to generate results to support a risk-informed submittal. As such, it applies to all the parts[1] of a PRA that support the results that inform the regulatory decision being made.

Review Interfaces

Other SRP sections interface with this section as described in the applicability section.

II. ACCEPTANCE CRITERIA

Acceptance criteria are based on the Commission's policy statements (Reference 11) and, for reactors licensed under Part 52, on meeting the relevant requirements of the Commission's regulations. If the applicant shows that its PRA model meets the regulatory positions set forth in RG 1.200, the technical reviewer should be able to conclude that the PRA is technically adequate. If exceptions to RG 1.200 have been identified and the staff has determined that the exceptions would not affect the risk results sufficiently to affect the regulatory decision, the staff should also be able to conclude that the PRA is technically adequate.

Requirements

The following regulatory requirements pertain to new reactors:

10 CFR 50.71(h)(1) requires that no later than the scheduled date for initial loading of fuel, each holder of a COL shall develop a Level 1 and a Level 2 PRA. The PRA must cover those initiating events and modes for which NRC-endorsed consensus standards on PRA exist 1 year prior to the scheduled date for initial loading of fuel.

10 CFR 50.71(h)(2) requires that each COL holder shall maintain and upgrade the PRA required by 10 CFR 50.71(h)(1). The upgraded PRA must cover initiating events and modes of operation contained in NRC-endorsed consensus standards on PRA in effect 1 year prior to each required upgrade. The PRA must be upgraded every 4 years until the permanent cessation of operations under 10 CFR 52.110(a).

10 CFR 50.71(h)(3) requires that each COL holder shall, no later than the date on which the licensee submits an application for a renewed license, upgrade the PRA required by 10 CFR 50.71(h)(1) to cover all modes and all initiating events.

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[1] In this SRP, a part of a PRA can be understood as being equivalent to that piece of the analysis for which an applicable PRA standard (i.e., ASME/ANS RA-Sa-2009) identifies a supporting level requirement.

SRP Acceptance Criteria

In order for the NRC staff to conclude that a PRA is of sufficient technical adequacy to support an application, the staff needs to be assured that (1) the parts of the PRA needed to support the application have been appropriately identified and (2) those parts are technically defensible. The former needs to be addressed as part of the assessment of the application. The latter can be met by determining that the necessary parts of the PRA have been performed in accordance with the staff position on consensus PRA standards and industry programs as documented in the appendices to RG 1.200. Where there are differences in approach to performing a specific part, the staff can determine that the approach used by the applicant is either equivalent to, or better than, that supported by the staff position.

III. REVIEW PROCEDURES

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternative would provide an acceptable method of complying with the relevant NRC requirements.

It should be clear that the elements of the model used to generate those results are of sufficient technical adequacy and that the assumptions and uncertainties that have the potential to affect the results have been properly evaluated and determined to be appropriate.

III.1 Scope of Review

In order to perform the review for PRA technical adequacy, the reviewer should first understand the context in which the PRA is being used.

III.1.1 Use of the PRA in the Application

The reviewer should become familiar with the way the PRA is used in the application. This includes understanding:

- the SSCs, operator actions, and plant operational characteristics that are affected by or important to the application.

- the cause-effect relationships between the change and the above SSCs, operator actions, and plant operational characteristics, where applicable.

- the mapping of the cause-effect relationships onto PRA model elements, where applicable.

- the acceptance criteria or guidelines, including identification of the PRA results that will be used to compare against the acceptance criteria or guidelines and how the comparison is to be made.

III.1.2 Scope of the PRA Model

The reviewer should identify the scope of the PRA (i.e., risk measures, hazard groups, and modes of plant operation) based on the application. For example, if the application applies the acceptance guidelines of RG 1.174, the evaluations of core damage frequency (CDF), the change in CDF (ΔCDF), large early release frequency (LERF), and the change in LERF (ΔLERF) should be performed with a full-scope PRA that includes all hazard groups and all modes of operation.

In accordance with the Commission direction on PRA technical adequacy, when the risk associated with a particular hazard group or operating mode is significant to the decision being made, and a staff-endorsed PRA standard exists for that hazard group or operating mode, then the risk should be assessed using a PRA that meets that standard.

For reactors, licensed under 10 CFR Part 52 the reviewer should become familiar with 10 CFR 50.71(h). As required by 10 CFR 50.71(h)(1), each COL holder shall develop a Level 1 and a Level 2 PRA no later than the scheduled date for initial loading of fuel. The PRA must cover those initiating events and modes for which NRC-endorsed consensus standards on PRA exist 1 year prior to the scheduled date for initial loading of fuel. In addition, 10 CFR 50.71(h)(3) requires that each COL holder shall upgrade the PRA required by 10 CFR 50.71(h)(1) to cover all modes and all initiating events no later than the date on which the licensee submits an application for a renewed license. With respect to this regulation, the reviewer should be aware that an all-mode, all-initiator PRA must be developed by the time a license renewal application is submitted, even if standards for such a PRA do not yet exist. It should be noted that the above regulations may have a significant impact to the decision being made for a risk-informed license amendment request.

Screening and conservative analyses may be used to demonstrate that the risk contributions not addressed by a PRA model are not significant to the decision. This is discussed more fully in NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making." Decision makers may address these omissions in other ways. Examples of allowances include the introduction of compensatory measures, and restriction of the implementation of the proposed change to the aspects of the plant covered by the risk model. This SRP section does not address this aspect of decision making but focuses on what PRA information should be provided. The reviewer's responsibility is to understand the scope of the PRA used in the decision making so that the appropriate appendices to RG 1.200 are identified as references for the review.

III.1.3 Parts of the PRA Model Used in Application

To assess the technical adequacy of the PRA input for a decision, the licensee should identify which parts of the PRA are used to provide the PRA results that will be compared to acceptance criteria or guidelines that apply to the application. For example, for license amendments, these parts of the PRA include not only the logic model events onto which the cause-effect relationships are mapped, but also all the events that appear together with those events in the affected accident sequences, and the parts of the analysis needed to evaluate the necessary results. For some applications, this may be a limited set, but for others (e.g., risk-informing the scope of special treatment requirements) all parts of the PRA model are relevant. In addition, when the assessed impact of a proposed change is measured in terms of ΔCDF or ΔLERF as described in RG 1.174, the total CDF and LERF should also be considered, broadening the scope of review for technical adequacy.

The reviewer, in applying this SRP section, should become familiar with those parts of the PRA identified as supporting the PRA results.

III.2 Assessment of the PRA

The reviewer should ensure that the parts of the PRA used for the application are of sufficient technical adequacy. The PRA should be technically sound. This means that (1) the PRA model, or the parts of the model relied upon to support the application, represent the as-built and as-operated[2] plant, which in turn means that the PRA is up-to-date and reflects the current design and operating practices, (2) the PRA model is developed based on acceptable methods and data, and (3) the probabilities and frequencies are estimated consistent with the definitions of the corresponding events of the logic model.

The engineering analyses, assumptions, and approximations used in developing the PRA model should be appropriate and demonstrate the robustness of the conclusions with respect to the uncertainties in the assessment. There are issues for which there is no consensus on analytical models or methods of analysis. Furthermore, PRAs are models, and in that sense the developers of those models rely on certain approximations to make the models manageable and on certain assumptions to address the uncertainties concerning the modeling of certain issues. This is recognized in RGs such as RG 1.174, which gives guidance on how to address the uncertainties by, for instance, performing appropriate sensitivity analyses. This aspect is expected to be addressed in the RGs and associated SRP sections that are applicable to a particular application.

III.2.1 Determination that the PRA Model is Current

When using risk insights based on a PRA model, the PRA model should reasonably represent the as-built and as-operated plant. “Reasonableness” is judged relative to the application being considered. For NFPA 805 applications, 10 CFR 50.48(c), which incorporates NFPA 805 by reference, requires that the PRA approach, methods, and data be appropriate for the nature and scope of the change being evaluated, be based on the as-built and as-operated and maintained plant, and reflect the operating experience at the plant. For new reactors, the licensee shall maintain and upgrade the PRA in accordance with the requirements of 10 CFR 50.71(h).

The reviewer should confirm that the PRA has been revised to reflect any significant changes in design or operational practices (including operating procedures), and that the data used to estimate the parameters are current. This may be achieved by reviewing the licensee's description of its updating process and ascertaining that the licensee has adequately addressed recent plant modifications and operational changes that could have a significant impact on the results of the specific application that are not reflected in the current PRA model.

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[2] For new reactors, since plant-specific operational data (i.e., initiating event frequencies, failure rates, etc.) and test and maintenance data may not yet be available in sufficient quantity, the staff should ensure that the impact caused by the use of generic experience or data is insignificant or otherwise acceptable. The staff should assess relevant assumptions and data to ensure that the PRA is statistically and feasibly developed.

III.2.2 Assessment of the Technical Adequacy of the PRA Required by the Application

The parts of the PRA relied upon by the application should be assessed for technical adequacy. The reviewer should determine that the peer review and self-assessment have been performed in conformance with the relevant documents and with the exceptions and clarifications found in the appendices to RG 1.200.

The reviewer should understand that the PRA standard allows each technical requirement provided in the standard to be assessed at various capability categories based on the risk-informed application. As stated in Section 1-1.3.3 of the ASME/ANS PRA Standard (Reference 4):

> The intent of the delineation of the Capability Categories within the SRs is generally that the degree of scope and level of detail, the degree of plant-specificity, and the degree of realism increases from Capability Category I to Capability Category III. However, the Capability Categories are not based on the level of conservatism (i.e., tendency to overestimate risk due to simplifications in the PRA) in a particular aspect of the analysis. The level of conservatism may decrease as the Capability Category increases and more detail and more realism are introduced into the analysis. However, this is not true for all requirements and should not be assumed….
>
> When a specific application is undertaken, judgment is needed to determine which Capability Category is needed for each portion of the PRA, and hence which SRs apply to the applications.

For further information, the reviewer is referred to Table 1-1.3-3 of the ASME/ANS PRA Standard.

Implementation of RG 1.200 should obviate the need for a detailed staff review of the baseline PRA for a risk contributor (e.g., internal events, internal floods, internal fires, external hazards) for which a standard and a corresponding appendix to RG 1.200 exist. A staff review of those PRAs for the risk contributors significant to the decision and for which no standard has been endorsed in RG 1.200 will be necessary to the extent needed to support the decision. However, even for the risk contributors addressed by standards, the staff may, under certain circumstances, decide to perform an audit to verify the technical adequacy of the PRA. An audit may be initiated for a number of reasons, some of which are identified below:

- Lack of evidence that the self-assessment actions[3] that are most relevant to the application have been adequately performed.

[3] Self assessment actions are relevant for current operating reactor applications when the original or current peer review was performed using criteria (e.g., peer reviews using early Boiling Water Reactor Owners Group (BWROG) guidance and peer reviews using the NEI 00-02 subtier criteria) that are different from the provisions of ASME/ANS RA-Sa-2009 as endorsed by RG 1.200.

- Concerns about the resolution of peer review findings associated with the PRA technical requirements that apply to the application.

- Contributors (e.g., accident sequences, cutsets, operator actions, etc.) to the results that differ from those seen at other, similar plants, and for which no plant-specific design features can be identified that would explain the differences.

- Results that seem to be counterintuitive, e.g., a decrease in CDF when equipment is taken out of service.

- Estimates of CDF or LERF that differ significantly from those in prior submittals from the same licensee, without a sufficient explanation.

It is expected that a licensee using a PRA standard or standards and the industry peer-review process has taken account of the exceptions and clarifications found in the appendices of RG 1.200 and has documented the assessment of these matters with the relevant documents as endorsed.

The capability category needed for each PRA supporting requirement of the applicable PRA standard technical element is dependent on the application. In general, the staff anticipates that current good practice, i.e., Capability Category II of the ASME/ANS Standard, is the level of detail that is adequate for the majority of applications. However, for some applications, Capability Category I may be sufficient for some PRA supporting requirements, whereas for other applications it may be necessary to achieve Capability Category III for specific PRA supporting requirements.

The reviewer should focus on the elements that have deviations from, or have discrepancies with, the PRA technical requirements of the endorsed documents. The reviewer should ensure that the deviation or discrepancy is acceptable as compared to the endorsed documents. The reviewer should also determine that the issues have been addressed adequately when the licensee provides reasons as to why the discrepancies are not important, or demonstrated that the discrepancy has no significant impact on the results used in the decision.

III.2.3 Assessment of Engineering Analyses, Assumptions, and Approximations

Since the standards and industry PRA programs are not (or are not expected to be) prescriptive, there is some freedom on how to model certain issues in the PRA. In dealing with this model uncertainty, different analysts may make different assumptions regarding these issues, yet the issues still meet the PRA standard or have been accepted by the peer review. The choice of a specific assumption or a particular approximation may, however, influence the results of the PRA. The staff should ensure that the conclusions drawn from the PRA are not invalidated by the use of specific assumptions. This is addressed primarily in the application-specific assessment through the use of sensitivity analyses. The staff should review the licensee's basis for those assumptions and their justification, taking into account the peer reviewers' assessment. The staff should determine whether the assumptions have been characterized appropriately, and whether there is sufficient information to conclude that the sensitivity studies performed to test the robustness of the conclusions are reasonable with respect to what is seen in current PRA practice. The staff's focus should be on assessing the licensee's approach to the identification of the key assumptions, which are those made in response to key sources of uncertainty, and on assessing the appropriateness of the key assumptions.[4]

IV. EVALUATION FINDINGS

If acceptable, the reviewer should provide documentation to conclude that the elements of the PRA relied upon to produce the results have been performed in such a way that the PRA results are fully supportable.

IV.1 Assessment of PRA against the Endorsed Standards

The PRA elements are assessed to determine whether they have been performed in a technically correct manner that conforms to the NRC endorsed PRA standards. This can be determined by an assessment of whether the PRA elements are performed consistent with the standard and peer review process as endorsed in the appendices to RG 1.200, or, if a discrepancy exists, whether the approach used is equivalent to, or better than that referenced in the standard or peer review process document. Alternatively, the reviewer may rely on a demonstration that the impact on the results used in the application is not significant.

IV.2 Key Assumptions and Key Sources of Uncertainty

The reviewer should not approve this portion of the analysis in the application unless the reviewer is satisfied that the key assumptions and key sources of uncertainty identified as having the potential to significantly impact the particular PRA results have been characterized in an acceptable manner given the current state of knowledge, and that the characterization has taken into account the results of the peer review.

V. IMPLEMENTATION

This SRP is intended to be used in conjunction with, and in support of, an application-specific SRP such as SRP Section 19.0, Section 19.2, Section 16.1, Section 9.5.1.2, Section 3.9.7, or Section 3.9.8.

VI. REFERENCES

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

2. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

3. American Society of Mechanical Engineers/American Nuclear Society. "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," Revision 1, ASME RA-S-2002. ASME/ANS RA-S-2008. ASME: New York, NY. ANS: La Grange Park, IL. April 2008.

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[4] In the ASME/ANS PRA Standard (Reference 4) a source of model uncertainty is labeled "key" when it could impact the PRA results that are being used in a decision, and consequently, may influence the decision being made.

4. American Society of Mechanical Engineers/American Nuclear Society. “Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications,” Addendum A to ASME/ANS RA-S-2008. ASME/ANS RA-Sa-2009, ASME: New York, NY. ANS: La Grange Park, IL. February 2009.

5. Nuclear Energy Institute. “Probabilistic Risk Assessment (PRA) Peer Review Process Guidance.” Revision A3, NEI 00-02. NEI: Washington, DC. March 20, 2000.

6. Nuclear Energy Institute. “Process for Performing Follow-On PRA Peer Reviews Using the ASME PRA Standard.” Revision 2, NEI 05-04. NEI: Washington, DC. November 2008.

7. Nuclear Energy Institute. “Fire Probabilistic Risk Assessment (FPRA) Peer Review Process Guidelines,” Draft Version H, Revision 0, NEI 07-12. NEI: Washington, DC. November 2008.

8. U.S. Nuclear Regulatory Commission. “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis.” Revision 1, Regulatory Guide 1.174. NRC: Washington, DC. July 2002.

9. U.S. Nuclear Regulatory Commission. “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-informed Activities.” Revision 2, Regulatory Guide 1.200. NRC: Washington, DC. March 2009.

10. U.S. Nuclear Regulatory Commission. “Combined License Applications for Nuclear Power Plants (LWR Edition).” Regulatory Guide 1.206. NRC: Washington, DC. June 2007.

11. U.S. Nuclear Regulatory Commission. “Addressing PRA Quality in Risk-Informed Activities.” SECY-00-0162. NRC: Washington, DC. July 28, 2000.

12. U.S. Nuclear Regulatory Commission. “Regulatory Guide 1.200 Implementation.” Regulatory Issue Summary 2007-06. NRC: Washington, DC. March 22, 2007.

13. U.S. Nuclear Regulatory Commission. “Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making.” NUREG-1855. NRC: Washington, DC. March, 2009.

14. Vietti-Cook, A. (NRC) to W.D. Travers (NRC). *Staff Requirements Memorandum*. “Staff Requirements - Briefing on Risk-Informed Regulation Implementation Plan (SECY-00-0062), March 31, 2000.” NRC: Washington, DC. April 18, 2000.

15. Vietti-Cook, A. (NRC) to W.D. Travers (NRC). *Staff Requirements Memorandum*. “Staff Requirements - Addressing PRA Quality In Risk-Informed Activities.” NRC: Washington, DC. October 27, 2000.

16. Vietti-Cook, A. (NRC) to W.D. Travers (NRC). *Staff Requirements Memorandum*. “Staff Requirements - COMNJD-03-0002 - Stabilizing the PRA Quality Expectations and Requirements.” NRC: Washington, DC. December 18, 2003.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

SRP Section 19.1
"Determining the technical adequacy of probabilistic risk assessment for risk-informed license amendment requests after initial fuel load"
Description of Changes

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Revision 2, dated June 2007 of this SRP. See ADAMS Accession No. ML07170057.

The technical changes incorporated in Revision 3, dated May 2012:

The tile of this section is modified from the earlier Revision 2 as shown above.

I. <u>AREAS OF REVIEW</u>

1. Deleted the development history of the ASME and ANS Standards.

2. Updated text to include regulatory requirements in 10 CFR 50.71(h)(1), (h)(2), and (h)(3).

3. Updated text to indicate the development and issuance of Revision 2 to RG 1.200.

4. Updated text to indicate the issuance of RIS 2007-06.

5. Updated text to indicate the issuance of NEI 07-12.

6. Added transition to NFPA 805 to applicability.

7. Added footnote to explain changes to text.

VI. <u>REFERENCES</u>

1. Updated references to reflect the issuance of combined ASME/ANS Standard and Addendum A.

2. Added NEI 05-04.

3. Added NEI 07-12.

4. Added Revision 2 to RG 1.200.