June 21, 2007

MEMORANDUM TO: John D. Monninger, Deputy Director
Probabilistic Risk and Applications
Division of Risk Assessment and Special Projects
Office of Nuclear Regulatory Research

FROM: Mary Drouin, Senior Program Advisor ***/RA/***
Probabilistic Risk and Applications
Division of Risk Assessment and Special Projects
Office of Nuclear Regulatory Research

SUBJECT: NOTICE OF PUBLIC MEETING WITH NUCLEAR ENERGY INSTITUTE (NEI), ELECTRIC POWER RESEARCH INSTITUTE (EPRI) AND OTHER INTERESTED STAKEHOLDERS REGARDING TREATMENT OF UNCERTAINTIES

DATE AND TIME: July 10, 2007
8:30 a.m. to 4:30 p.m.

LOCATION: NEI Office
1776 I St. N.W., Suite 400
Washington, DC 20006

PURPOSE: To discuss issues related to treatment of uncertainties and assumptions associated with probabilistic risk assessments.

PARTICIPANTS:

NRC	NEI
Mary Drouin (RES)	Biff Bradley
Gareth Parry (NRR)	EPRI
Marty Stutzke (NRO)	Ken Canavan

CATEGORY* This is a category 2 meeting. The public is invited to participate by discussing technical issues with NRC staff at designated points during the meeting.

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*Meetings between the NRC technical staff and applicants or licensees are open for interested members of the public, petitioners, interveners or other parties to attend as observers pursuant to "Commission Policy Statement on Enhancing Public Participation in NRC Meetings," 67 Federal Register 36920, May 28, 2002.

Enclosure:
Agenda

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Enclosure:
Agenda

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NRC Meeting
July 10, 2007 -- 8:30pm-4:30pm
NEI Office

Agenda

8:30 am - 8:40am	INTRODUCTION	(NRC)
8:40 am -04:00 pm	Topics*	(All)
4:10 pm - 4:30 pm	Closing Remarks	(NRC)
4:30 pm	Adjourn	

***General Discussion Topics**

- Regulatory Guide 1.200, Revision 1
  - — regulatory position on treatment of sources of uncertainties and assumptions
  - — regulatory position on requirements in ASME RA-Sb-2005 standard

  Note: A draft of the NRC's clarification to the staff' regulatory position is attached.

- NRC NUREG on Treatment of PRA Uncertainties in Risk-Informed Decision Making

- EPRI Documents on Treatment of Uncertainty in Risk-Informed Regulatory Applications
  - — Technical Basis Document
  - — Applications Guide Document

- Aggregation of Quantitative Risk Assessment Results

- Future Meetings

Enclosure

ATTACHMENT
Draft Clarification to Regulatory Guide 1.200, Revision 1

INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) is issuing a clarification to an existing guide in the agency's regulatory guide (RG) series. The NRC has developed this series to describe and make available to the public such information as methods that are acceptable to the NRC staff for implementing specific parts of the NRC's regulations, techniques that the staff uses in evaluating specific problems or postulated accidents, and data that the staff needs in its review of applications for permits and licenses.

At this time, the NRC is issuing a clarification to Revision 1 of RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," issued January 2007. The purpose of this clarification is to provide additional explanation of the staff's regulatory position with regard to defining the technical acceptability of a probabilistic risk assessment (PRA), specifically with respect to the treatment of sources of uncertainty and assumptions in the base PRA.

BACKGROUND

RG 1.200 describes one acceptable approach for determining whether the quality of the PRA, in total or the parts that are used to support an application, is sufficient to provide confidence in the results such that the PRA can be used in regulatory decision making for light-water reactors.

Section C of RG 1.200 provides the regulatory position on the technical adequacy of the base PRA. One aspect in defining PRA technical adequacy is the treatment of assumptions and sources of uncertainty. The staff's position on this technical issue is discussed in several places in RG 1.200. While the staff's regulatory position in Revision 1 did not change (from Revision 0 or Draft Guide 1161), additional explanation is being provided to clarify the staff's regulatory position on the treatment of assumptions and sources of uncertainty as stated in Revision 1 to RG 1.200. The staff will incorporate this clarification into the next revision of RG 1.200.

American Society of Mechanical Engineers (ASME) standard RA-S-2002, "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," dated April 5, 2002, sets forth requirements for PRAs used to support risk-informed decisions for commercial nuclear power plants. ASME has since issued two addenda (ASME RA-Sa-2003 and ASME RA-Sb-2005). Appendix A to RG 1.200, Revision 1, provides the staff position on the requirements in this standard which includes the treatment of assumptions and sources of uncertainty. The staff has "No objection with clarification" to the definitions in the standard and to certain requirements in the standard on assumptions and sources of uncertainty. (Note that the staff's regulatory position of "No objection with clarification" is defined as: The staff has no objection to the requirement; however, the requirement, as written, is either unclear or ambiguous; therefore, the staff has provided its understanding of the requirement.) While the staff's regulatory position in Revision 1 in Appendix A to RG 1.200 did not change (from Revision 0 or Draft Guide 1161), additional explanation is being provided to clarify the staff's regulatory position to the ASME standard as documented in Appendix A in Revision 1 to RG 1.200. The staff will incorporate this clarification into the next revision of RG 1.200.

The staff's view with regard to the treatment of sources of uncertainty and assumptions is as follows:

- The sources of uncertainty and assumptions in the base PRA only need to be identified and characterized (not every source of uncertainty and every assumption need to be evaluated for the base PRA).

- The impact of the sources of uncertainty and assumptions only need to be evaluated in the context of an application so that, when the PRA is used to support an application, their impact on the PRA results used to support the application are understood.

DISCUSSION OF THE ISSUE

In the ASME standard, high level requirement (HLR) HLR-QU-E states:

> "Uncertainties in the PRA results shall be characterized. Key sources of model uncertainty and key assumptions shall be identified, and their potential impact on the results understood."

One of the associated supporting requirements (SR), QU-E4, states:

> "Cat I –
> PROVIDE an assessment of the impact of the key model uncertainties on the results of the PRA.
> Cat II –
> EVALUATE the sensitivity of the results to key model uncertainties and key assumptions using sensitivity analyses.
> Cat III –
> EVALUATE the sensitivity of the results to uncertain model boundary conditions and other key assumptions using sensitivity analyses except where such source of uncertainty have been adequately treated in the quantitative uncertainty analysis."

The definitions for key source of uncertainty and key assumption in the ASME standard are:

> "*A key source of uncertainty*: a source of uncertainty that is related to an issue for which there is no consensus approach or model and where the choice of approach or model is known to have an impact on the risk profile (e.g., total CDF and total LERF, the set of initiating events and accident sequences that contribute most to CDF and to LERF) or a decision being made using the PRA. Such an impact might occur, for example, by introducing a new functional accident sequence or a change to the overall CDF or LERF estimates significant enough to affect insights gained from the PRA.
>
> *Key assumption*: an assumption made in response to a key source of uncertainty in the knowledge that a different reasonable alternative assumption would produce different results, or an assumption that results in an approximation made for modeling convenience in the knowledge that a more detailed model would produce different results. For the base PRA, the term "different results" refers to a change in the plant risk provide (e.g., total CDF and total LERF, the set of initiating events and accident

> sequences that contribute most to CDF and to LERF) and the associated changes in insights derived from the changes in risk profile. A "reasonable alternative" assumption is one that has broad acceptance within the technical community and for which the technical basis for consideration is at least as sound as that of the assumption being challenged."

SR QU-E4 does meet the objective of HLR-QU-E and the definitions for key sources of uncertainties and key assumptions are open-ended.

The sources of uncertainty and assumptions in a PRA need to be identified and characterized. With regard to an application, for those sources and assumptions that could impact the specific PRA results that are being used in the decision, the characterization should involve assessing the degree to which they impact the PRA results. The SRs of QU-E1 through E4 in the standard require the identification of the sources of model uncertainty and assumptions in the base PRA (QU-E1 and E2) and the analysis of their impact on the results (QU-E4) [QU-E3 deals with parameter uncertainties]. The problem in attempting to meet the specific requirement of QU-E4 is that it is requiring a quantitative assessment of the key sources and key assumptions for the base PRA independent of an application.

In determining the quantitative impact on the PRA results, the impact is assessing how much the results (e.g., CDF) may change as a result of the uncertainty or assumption. This quantitative assessment does not need to be performed for every source of uncertainty and every assumption in the base PRA. In the standard, it attempts to limit the list in the base PRA to the "key" sources and assumptions. However, in order to identify the "key" sources and assumptions, numerical criteria are needed. The definition in the standard for "key" includes the phrases: "have an impact on the risk profile" and "significant enough to affect insights gained from the PRA." These words do not limit the list; even a very minor change could be categorized as an impact on the PRA results (e.g., CDF). Consequently, every source and assumption could be considered "key." The definition needs to have numerical criteria rather than ambiguous qualitative words as "impact" or "significant enough."

To develop numerical criteria that would be used to select "key" sources and assumptions in the base PRA, they would need to be relevant to the acceptance criteria that are being used in the decision making. For example, an application for a licensing base change using the acceptance criteria in RG 1.174: a "key" source or assumption could be one that has the potential to change the degree to which the risk acceptance criteria are met, and therefore, could potentially influence the decision; therefore, a source of uncertainty or assumption could be considered "key" if it results in uncertainty regarding whether the result lies in Region II or Region I, or if it results in uncertainty regarding whether the result becomes close to the region boundary or not.

It is the numerical acceptance criteria that provide the basis for identifying which sources of uncertainty and assumptions can potentially challenge the decision, and therefore, which ones would then be identified as "key." Consequently, to define the "key" sources and assumptions for the base PRA would require identifying all the various applications along with the risk acceptance criteria being used in the decision making. In other words, the "key" sources of uncertainty and assumptions are relevant in the context of an application.

Although it is not necessary to quantitatively assess the impact of every source of uncertainty and assumption in the base PRA, the search for candidates needs to be fairly complete (regardless of capability category), since it is not known a priori, which of them could affect an application. As with initiating events (as required in the standard), identification of the events that can challenge normal plant operation and require successful mitigation is independent of the capability category; the distinction and differentiation between the categories is in the assessment of the events. Similarly, the identification of the sources of uncertainty and assumptions is independent of the categories with the differentiation in their assessment. The goal is to identify and characterize those sources of uncertainty and assumptions in the base PRA model that have the potential to impact the PRA results to the extent that a decision being made using the PRA could be affected. This characterization is a qualitative assessment. Characterizing a source of uncertainty or assumption means identifying what it affects in the base PRA model. The range of effects can include issues, for example, associated with:

- the determination of success criteria that can influence the event tree structure and can introduce new accident sequences or affect the relative significance of accident sequences

- affecting specific basic events

This characterization is essential to perform any sort of screening, whether qualitative or quantitative, to limit the scope of sources of uncertainty and assumptions that are potentially relevant to an application.

STAFF CLARIFICATION

Main Body of RG 1.200, Revision 1

In several places in the main body of the RG, the staff's regulatory position addresses the treatment of assumptions and sources of uncertainty. While the staff position has not changed (from Revision 0 or Draft Guide 1161), the following clarifications are provided to the text:

- ***Regulatory Position C.1.2.6, Interpretation of Results***

  "An important aspect in understanding the base PRA results is understanding the potential impact of parameter and model uncertainties. The impact of parameter uncertainties is gained through the actual quantification process. The impact of model uncertainties can be evaluated qualitatively or quantitatively. The sources of model uncertainty are identified in terms of how they affect the base PRA model (e.g., introduction of a new basic event, changes to basic event probabilities, change in success criterion, introduction of a new initiating event). Some sources of uncertainty may be screened from further consideration following an assessment of their potential significance by, for example, qualitative discussion or on the basis of sensitivity analysis. . . . When using sensitivity analyses to screen model uncertainties, model boundary conditions, and other assumptions, the sensitivity analyses look at these both individually and in logical combinations. . . ."

- ***Regulatory Position C.1.2.7, Documentation***

  ". . . . Sources of model uncertainty are identified and their potential impact on the results assessed (see the discussion in Section 1.2.6). Assumptions that are not screened out are documented along with their justification to the extent that the context of the assumption is understood. . . ."

- ***Regulatory Position C.1.3, Table 4, Interpretation of Results***

  "Identification of sources of model uncertainty and their potential impact on the base PRA results."

- ***Regulatory Position C.3.3.2, Assessment of Assumptions and Approximations, Footnote 1***

  "*An assumption* is a decision or judgment that is made in response to a source of uncertainty in the knowledge that a different reasonable alternative assumption would produce different results, or an assumption that results in an approximation made for modeling convenience in the knowledge that a more detailed model would produce different results. For the base PRA, the term "different results" refers to a change in the plant risk provide (e.g., total CDF and total LERF, the set of initiating events and accident sequences that contribute most to CDF and to LERF) and the associated changes in insights derived from the changes in risk profile. A "reasonable alternative" assumption is one that has broad acceptance within the technical community and for which the technical basis for consideration is at least as sound as that of the assumption being challenged. An assumption is labeled "key" because it is made in response to a "key" source of uncertainty."

  "*A source of uncertainty* is one that is related to an issue in which there is no consensus approach or model and where the choice of approach or model is known to have an effect on the PRA model (e.g., introduction of a new basic event, changes to basic event probabilities, change in success criterion, introduction of a new initiating event). A source of 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. The impact on the PRA results could, for example, be changing the risk profile (e.g., total CDF and total LERF, the set of initiating events and accident sequences that contribute most to CDF and to LERF, introduction of a new functional accident sequence). This impact would be need to be significant enough that it changes the degree to which the risk acceptance criteria are met, and therefore, could potentially influence the decision. For example, a source of uncertainty or assumption could be considered "key" if it results in uncertainty regarding whether the result lies in Region II or Region I, or if it results in uncertainty regarding whether the result becomes close to the region boundary or not."

Appendix A to RG 1.200, Revision 1

Appendix A to RG 1.200, Revision 1 provides the staff's position on the requirements in ASME RA-S-2002 and Addenda. In several places in Appendix A, the staff's regulatory position addresses the treatment of assumptions and sources of uncertainty within the requirements of the ASME standard. While the staff position has not changed (from Revision 0 or Draft Guide 1161), the following clarifications are provided to the staff's objections:

- ***Table A-1, Chapter 2, Key Assumption, Staff Issue***

  ". . . . See the discussion on staff regulatory positions C.1.2.6, C.1.2.7, and C.3.3.2."

- ***Table A-1, Chapter 2, Key Source of Uncertainty, Staff Issue***

  ". . . . See the discussion on staff regulatory positions C.1.2.6, C.1.2.7, and C.3.3.2."

- ***Table A-1, Chapter 2, Key Assumption and Key Source of Uncertainty, Staff Position and Resolution***

  "~~*Key assumption:* an assumption made in response to a key~~ ***Assumption:*** **a decision or judgment that is made in response to a** source of uncertainty in the knowledge that a different reasonable alternative assumption would produce different results, or an assumption that results in an approximation made for modeling convenience in the knowledge that a more detailed model would produce different results . . . . as sound as that of the assumption being challenged. ***An assumption*** **is labeled "key" because it is made in response to a "key" source of uncertainty.**"

  "~~*Key s*~~***S****ource of uncertainty*: ~~a source of uncertainty~~ **one** that is related to an issue for which there is no consensus approach or model and where the choice of approach or model is known to have an **effect on the PRA model (e.g., introduction of a new basic event, changes to basic event probabilities, change in success criterion, introduction of a new initiating event). A source of 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. The impact on the PRA results could, for example, be changing the risk profile (e.g., total CDF and total LERF, the set of initiating events and accident sequences that contribute most to CDF and to LERF, introduction of a new functional accident sequence). This impact would be need to be significant enough that it changes the degree to which the risk acceptance criteria are met, and therefore, could potentially influence the decision. For example, a source of uncertainty or assumption could be considered "key" if it results in uncertainty regarding whether the result lies in Region II or Region I, or if it results in uncertainty regarding whether the result becomes close to the region boundary or not.** ~~impact on the risk profile (e.g., total CDF and total LERF, the set of initiating events and accident sequences that contribute most to CDF and to LERF) or a decision being made using the PRA. Such an impact might occur, for example, by introducing a new functional accident sequence or a change to the overall CDF or LERF estimates significant enough to affect insights gained from the PRA.~~"

- ***Table A-1, QU-E4, Staff Issue***

  "What is meant by "all" is discussed in staff regulatory position C.1.2.6. The staff regulatory position focuses the search so that it is not unlimited. It is only in the context of an application that the need exists to quantitatively assess the impact of an assumption or a source of uncertainty."

- ***Table A-1, QU-E4, Staff Position and Resolution***

  "~~Cat I: PROVIDE an assessment of the impact . . . . Cat II: EVALUATE the sensitivity of the results . . . . Cat III: EVALUATE the sensitivity of the results . . . .treated in the quantitative uncertainty analysis~~.
  Cat I, II, III
  For each source of model uncertainty and assumption identified in QU-E1 and QU-E2, respectively, IDENTIFY how the PRA model is affected (e.g., introduction of a new basic event, changes to basic event probabilities, change in success criterion, introduction of a new initiating event) [Note (1)]."

- ***Appendix A, Table A-1, 6.1, Peer Review, Purpose, Staff Issue***

  ". . . . Another key objective is for the peer review to assess the appropriateness of the assumptions. This assessment need only focus on the assumptions that have the potential to affect the risk profile as discussed in Sections C.1.2.6 and C.3.3.2. . . ."

- ***Table A-1, 6.1, Peer Review, Purpose, Staff Position and Resolution***

  ". . . . The peer review shall assess the PRA to the extent necessary to determine if the methodology and its implementation meet the requirements of this **s**tandard to determine the strengths and weaknesses in the PRA. **Therefore, the peer review shall also assess the appropriateness of the assumptions by reviewing the screening criteria to determine that assumptions were not inappropriately screened out.** The peer review need not assess . . . ."

The clarification to Regulatory Guide 1.200, Revision 1, is intended for licensees of nuclear power plants. Revision 1 of this RG remains in effect for licensees of nuclear power plants.