

# Public Meeting on Treatment of PRA Uncertainties in Risk- Informed Decision Making

July 10, 2007

# Objective of Meeting

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- To discuss issues related to sources of uncertainty and assumptions associated with probabilistic risk assessment and their treatment in risk-informed decision making
- Category 2 public meeting

# Agenda

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- 8:30 – 8:40 am Introduction
- 8:40 – 9:30 am Regulatory Guide 1.200, Revision 1
- 9:30 – 11:00 am NRC NUREG on Treatment of Uncertainties
- 11:00 – 11:45 am Aggregation
- 11:45 – 1:00 pm LUNCH
- 1:00 – 3:45 pm EPRI Documents on Treatment of Uncertainties
- 3:45 – 4:00 pm Milestones, schedule, meetings
- 4:00 – 4:30 pm Wrap-up and closing remarks
- 4:30 pm Adjourn

# Regulatory Guide 1.200

# Treatment of Uncertainties and Assumptions -- Overview

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- Must have an understanding of the PRA model before using it
  - Part of this understanding is knowing what are the sources of uncertainty and assumptions and their potential impact
  - Understanding the impact means developing a characterization and then, where appropriate, performing an evaluation
  - For the base PRA (absent an application), only a characterization is needed
    - Knowing *what and where* in the PRA model could be impacted
  - For an application, an evaluation is needed
    - Knowing *the extent to which* the PRA model is affected
- ⇒ **ASME standard on this issue is too subjective and consequently, it is difficult to demonstrate compliance**

# Regulatory Guide, Revision 1

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- In reviewing the public comments on Draft Guide 1161 and finalizing staff position on ASME standard, staff noted an “issue” with certain requirements regarding sources of uncertainty and assumptions
- The staff position on this issue did not change with publication of Revision 1 to Regulatory Guide (RG) 1.200, however, the staff attempted to address/resolve the identified problem in Revision 1 of RG 1.200
- The staff is issuing a clarification (via a Federal Register Notice) whose purpose is to provide additional explanation to Revision 1 of RG 1.200 regarding the staff’s regulatory position with respect to the treatment of sources of uncertainty and assumptions in the base PRA versus applications

# ASME Standard

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- 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.”
- Supporting requirement (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

# ASME Standard (cont'd)

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- **Definition in ASME standard:**

*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 profile (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.

# ASME Standard (cont'd)

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- Definition in ASME standard:

*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.

# Concern with ASME Standard

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- Supporting requirement, QU-E4:
  - Does not meet the objective of the HLR-QU-E
  - Is “open-ended”
- An evaluation of the sensitivity on the results does not need to be performed for every source of uncertainty and every assumption in the base PRA
- Definitions for either “key” assumption or “key” source of uncertainty does not resolve the problem

# Concern with ASME Standard (cont'd)

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- The scope of sources of uncertainty is not limited with definitions using such words as
  - “have an impact on the risk profile”
  - “significant enough to affect insights gained from the PRA”
- Even a very minor change could be categorized as an impact on the PRA results (e.g., CDF)
  - Every source and assumption could be considered “key”
- Definition needs to have numerical criteria appropriate to an application rather than ambiguous qualitative words as “impact” or “significant enough.”

# Staff Position

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

# Staff Clarifications of RG 1.200, Revision 1

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- Additional explanation provided on staff regulatory position
- Definition of source of uncertainty and assumption
  - Use “key” in terms of relevance to an application
- Correct QU-E4 by having the SR the same for all categories to only require a characterization of uncertainties and assumptions in the base PRA and not an assessment

# Staff Clarifications of RG 1.200, Revision 1 (cont'd)

## ■ Regulatory Position C.1.2.6 (Interpretation of Results)

“An important aspect in understanding the base PRA results is understanding ~~the associated uncertainties~~ the potential impact of parameter and model uncertainties, and assumptions. The impact of parameter uncertainties is gained through the actual quantification process. The impact of model uncertainties and assumptions can be evaluated qualitatively or quantitatively. The sources of model uncertainty and assumptions are characterized 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 and assumptions 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 address these both individually and in logical combinations. The combinations analyzed are chosen to account for interactions among the variables. ~~Sources of uncertainty are identified and their impact on the results analyzed.~~ The potential conservatism . . . is assessed. ~~The sensitivity of ... logical combinations. The combinations analyzed are chosen to account for interactions among the variables.~~”

# Staff Clarifications of RG 1.200, Revision 1 (cont'd)

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

“Traceability and defensibility provide . . . . Sources of model uncertainty are identified and their potential impact on the results assessed (see the discussion in Section C.1.2.6). Assumptions made in performing the analyses are identified and 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***

Level 1 --

- “identification of sources of model uncertainty and their potential impact on the base PRA results”

Level 2 --

- “identification of sources of model uncertainty and their potential impact on the base PRA results”

# Staff Clarifications of RG 1.200, Revision 1(cont'd)

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

“ . . . . For each application that calls upon this regulatory guide, the applicant identifies the key assumptions<sup>7</sup> and approximations relevant to that application. This will be used to identify sensitivity studies as input to the decision-making associated with the application . . . . ”

(no clarification needed)

# Staff Clarifications of RG 1.200, Revision 1(cont'd)

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

~~"Key assumption: an assumption made in response to a key~~ **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 profile (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."**

# Staff Clarifications of RG 1.200, Revision 1(cont'd)

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

"A ~~key~~ source of uncertainty is 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 ~~impact on~~ 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. Therefore, a key source is identified in the context of an application. The impact on the PRA result 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) ~~such that it influences a decision being made using the PRA. Such an impact might occur, for example, by introducing~~ introduction of a new functional accident sequence or a change to the overall CDF or LERF estimates significant enough to affect insights gained from the PRA). This impact would 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. As examples, in a RG 1.174 type application, a source of uncertainty is 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."

# Staff Clarifications of RG 1.200, Revision 1(cont'd)

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- Appendix A, Table A-1, QU-E4, Staff Resolution:

- 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)].

# Staff Clarifications of RG 1.200, Revision 1(cont'd)

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

“. . . A key objective of the peer review . . . this goal is to be clearly understood by the peer review team. **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 standard 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 . . .”

# Next Steps . . .

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- Short term –
  - NRC to issue a Federal Register Notice that provides the clarifications on the previous slides
- Longer term --
  - NRC recommendation to ASME: In Revision 1 to ASME standard, ASME revise QU-E4 and definitions, as appropriate, to address/resolve the issue
  - Given staff agreement to ASME resolution, NRC staff remove objection in Revision 2 to RG 1.200

# NUREG-1855

(Treatment of Uncertainties in Risk-Informed  
Decision Making)

# NUREG-1855

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- Objective

- Provide guidance on how to treat uncertainties in PRA in risk-informed decision making
- Addresses parameter, model, and completeness uncertainties

- Intended to be complimentary with EPRI work on treatment of uncertainties

- Status

- To be issued as draft for public review and comment in August 2007
- To be referenced in RG 1.200, Revision 2

# NUREG-1855 (cont'd)

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## Organization/Outline

Chapter 1: Introduction

Chapter 2: Approach to Address Uncertainty in Risk-Informed Decision Making

Chapter 3: Risk Model Definitions and Sources and Types of Uncertainty

Chapter 4: Parameter Uncertainty

Chapter 5: Model Uncertainty

Chapter 6: Completeness Uncertainty

Chapter 7: Risk-Informed Decision Making: Dealing with Uncertainty

Appendix: Staff Position on EPRI documents

# NUREG-1855 (Cont'd)

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## **Chapter 1:** Introduction

- Provides the objectives, use, scope, and limitations of the NUREG
- Provides an overview of the organization of the NUREG

## **Chapter 2:** Approach to Address Uncertainty in Risk-Informed Decision Making

- Provides an overview of the overall approach used (in the NUREG) to address uncertainties in risk-informed decision making
- Provides the context for the role uncertainties play in the decision process
- Provides an overview of the risk-informed decision making process itself

# NUREG-1855 (Cont'd)

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**Chapters 3-6:** Details on the individuals pieces

**Chapter 3:** Risk Model Definitions and Sources and Types of Uncertainty

- Defines the characteristics of a risk model, and, in particular, a probabilistic risk assessment
- Identifies and describes the different classes of sources of uncertainty
  - The different classes are addressed in different ways

# NUREG-1855 (Cont'd)

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## **Chapter 4:** Parameter Uncertainty

- Provides guidance on how to address parameter uncertainty in the use of PRA results for decision making
  - Characterization of parameter uncertainty
  - Propagation of uncertainty
    - State of knowledge correlation
  - Comparison of results with acceptance criteria

# NUREG-1855 (Cont'd)

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## **Chapter 5: Model Uncertainty**

- Provides guidance for identifying and characterizing model uncertainties in PRAs
- Provides guidance on assessing what the impact of model uncertainties is on insights used for risk-informed applications
- Guidance provided in the context of two different types of applications:
  - The base-line PRA is used in a regulatory application, for example, to evaluate various design options or to determine the base-line risk profile as part of a license submittal for a new plant
  - The base PRA is used as input to evaluating proposed changes to a plant's licensing basis using RG 1.174

# NUREG-1855 (Cont'd)

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## **Chapter 6: Completeness Uncertainty**

- Provides guidance on addressing one aspect of completeness uncertainty (i.e., missing scope) in risk-informed applications
- Guidance is provided on the performance of conservative or bounding analysis as one means to address items missing from a plant's PRA scope

## **Chapter 7: Risk-Informed Decision-Making - Dealing with Uncertainty**

- Provides guidance on addressing the uncertainty in PRA results in the context of risk-informed decision making, and in particular on the interpretation of the results of the uncertainty analysis when comparing PRA results with the acceptance criteria established for a specified application
- Guidance for addressing the other elements contributing to completeness uncertainty in risk-informed decision making (e.g., unknown phenomena that have not been recognized or factors that have been identified but where there is no agreed method to address them in PRAs)

# NUREG-1855 (Cont'd)

## **Appendix A: Staff Position on EPRI Guidance Documents on Treatment of Uncertainties in Risk-Informed Regulatory Applications**

- A.1 – Staff position on Technical Basis Document
  - A.2 – Staff position on Applications Guide Document
- ⇒ Staff position still being formulated (i.e., working with EPRI to address staff concerns)

# NUREG-1855 (Cont'd)

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- Status and schedule
  - To be issued as draft for public review and comment, August 2007
  - Public review and comment period of 3 months
  - Public meeting and workshop to be scheduled, tentative dates--
    - Initial public meeting late September 2007 to present the NUREG
    - Public meeting/workshop late October 2007 to discuss in detail the NUREG
    - Public meeting in January 2008 to go over public comments and staff position
  - Issued for use March 2008



# Aggregation

# Aggregation

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- What is “aggregation”?

The addition of the risk measures/metrics (e.g., CDF) from different contributors (e.g., internal events, internal fire, seismic, LPSD) in estimating the overall risk.

# Aggregation (cont'd)

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- Industry objections raised to aggregation
  - Inconsistencies in
    - Levels of modeling detail
    - Conservative biases
    - Uncertainty
  - Results in overly conservative or erroneous decisions
- NRC does not believe inconsistencies in the PRA model creates a problem in decision making
  - Examples need to be provided that demonstrate this is an issue of concern for applications

# Aggregation – Staff Position

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- For an application, all the relevant contributors need to be included in the risk estimation
- The acceptance guidelines/criteria for an application require the contributions to be added
- Because there are different levels of detail, plant specificity, and realism among the analyses (whether the PRA is a full-scope PRA, e.g., internal and external events for all operating modes, or a limited-scope, e.g., internal events at full power), an understanding of the uncertainties and boundary conditions in the interpretation of the results is essential

# EPRI Documents

# EPRI Documents

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- Treatment of Uncertainties in Risk-Informed Regulatory Applications
  - Technical Basis Document
  - Applications Guide Document
- Staff plans to “endorse” in appendix to NUREG-1855
- Attended EPRI meeting May 16, 2007, and discussed NRC concerns

# NRC Concerns

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- Concerns in three areas:
  - Identification and characterization of sources of uncertainty and assumptions
  - Assessment of modeling uncertainties and assumptions
  - Assessment of parameter uncertainties

# Identification/Characterization of Sources and Assumptions

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- NRC Issues with EPRI Identification Guidance:
  - Not focused on the particular issue associated with the source of uncertainty and the characterization of its impact on the PRA
  - Not clear there is guidance to identify unique sources associated with the plant model of the PRA
  - No clear distinction between assumptions made as result of using approximate methods versus those due to modeling uncertainties
- NRC Understanding of EPRI Position:
  - EPRI will revise the list of generic model uncertainty issues

# Assessment of Modeling Uncertainties and Assumptions

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- NRC Issues:
  - Screening criteria need to be related to those used in the context of the application
    - EPRI Screening criteria used in the base PRA may screen out “key” uncertainties or assumptions important to the application
    - “key” uncertainties are those that challenge the acceptance criteria
  - Need to address risk profile in addition to numerical criteria
  - Guidance for selecting combinations is not sufficient
  - Guidance for choosing sensitivity studies is too general
  - Guidance for interpretation of results is insufficient
    - What is forwarded to the decision maker should include whatever can challenge the decision
- NRC Understanding of EPRI Position:
  - EPRI will revisit the criteria

# Assessment of Parameter Uncertainties

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- NRC Issue:
  - Guidance accounting for when and how to account for state-of-knowledge correlation can result in incorrect results
  - For example, common cause inclusion can mask the effect of state-of-knowledge correlation
- NRC Understanding of EPRI Position:
  - EPRI will revise the guidance on when to perform a detailed propagation of uncertainty

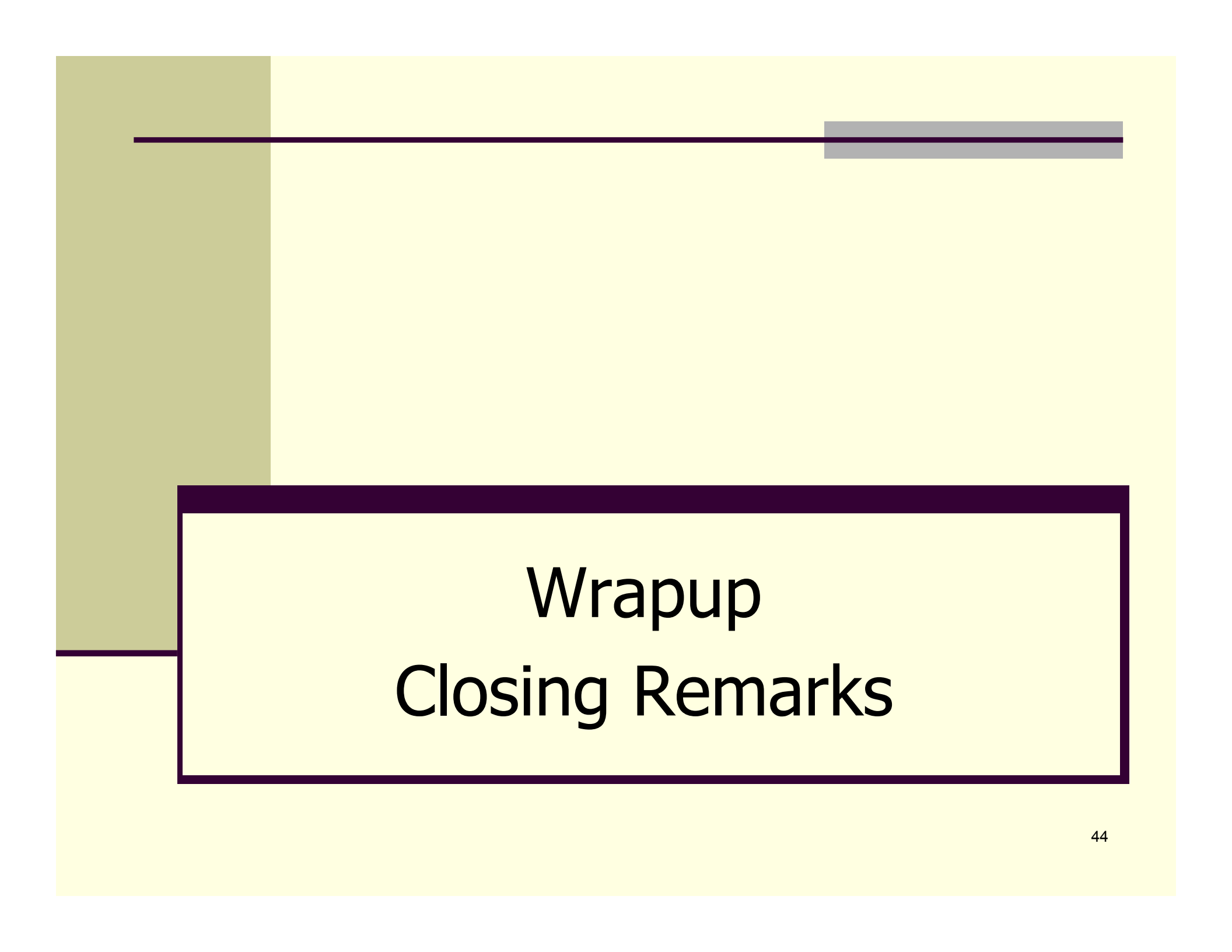


# Milestones, Schedule, Meetings

# Schedule

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July 2007:	Clarification on RG 1,200, Revision 1
August 2007:	Draft NUREG-1855 issued for public review and comment
Sept 2007:	Public meeting to present the NUREG
Oct/Nov 2007:	Public meeting/workshop to discuss in detail the NUREG
Dec 2007:	End of public review and comment period
Jan 2008:	Public meeting to go over public comments and staff position
March 2008:	Publication of NUREG
Dec 2008:	Revision 2, RG 1.200



# Wrapup

## Closing Remarks

# Summary

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- Federal Register Notice to be issued right after this public meeting
- Preference that ASME/ANS address/resolve the issue on treatment of uncertainties and assumptions in Revision 1 of ASME Sa-R
- NUREG-1855 is another technical document as part of the continuing effort, by both NRC and industry, to improve PRAs. For example:
  - NRC Data Handbook
  - NRC HRA Good Practices
  - EPRI Guideline for the Treatment of Uncertainty in Risk-Informed Applications: Technical Basis Document and Application Guide
  - EPRI Support System Initiating Events: Identification and Quantification Guideline
- Aggregation: All risk contributors relevant to an application have to be accounted for against the acceptance guidelines