



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001

December 14, 2007

MEMORANDUM TO: George E. Apostolakis, Chairman  
Subcommittee on Reliability and Probabilistic Risk Assessment

FROM: Hossein Nourbakhsh, Senior Staff Engineer **/RA/**

SUBJECT: STATUS REPORT FOR THE MEETING OF THE  
SUBCOMMITTEE ON RELIABILITY AND RISK ASSESSMENT  
DECEMBER 19, 2007, IN ROCKVILLE, MARYLAND

The purpose of this memorandum is to forward written materials for your use in preparing for the meeting of the ACRS Subcommittee on Reliability and Probabilistic Risk Assessment on December 19, 2007. The Subcommittee will discuss the draft NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking." The purpose of the meeting is to gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee. Attached please find the agenda, status report, and background materials.

Attendance by the following members is anticipated and reservations have been made at the following hotels for December 18-20, 2007.

Apostolakis	RESIDENCE INN
Abdel-Khalik	BETH. N. MARRIOTT
Armijo	BETH. N. MARRIOTT
Banerjee	BETH. N. MARRIOTT
Bonaca	BETH. N. MARRIOTT
Corradini	RESIDENCE INN
Shack	RESIDENCE INN
Seiber	RAMADA INN
Stetkar	BETH. N. MARRIOTT
Kress (Consultant)	RESIDENCE INN
Wallis (Consultant)	RESIDENCE INN

Please notify Ms. Barbara Jo White at 301-415-7130 if you need to change or cancel the above reservations.

Attachments<sup>1</sup>

1. Agenda
2. Status report
3. U. S. NRC, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking." NUREG-1855, Draft Report for Public Comment, October 2007.
4. Electric Power Research Institute, "Guideline for the Treatment of Uncertainty in Risk-Informed Applications: Technical Basis Document," EPRI-1009652, December 2004.
5. Electric Power Research Institute, "Guideline for the Treatment of Uncertainty in Risk-Informed Applications: Application Guide," EPRI-1013491, October 2006

cc: ACRS Members  
cc w/o attach: F. Gillespie  
C. Santos

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<sup>1</sup> Electronic copies of the supporting documents have been sent to members separately.

**Advisory Committee on Reactor Safeguards  
Meeting OF Subcommittee on Reliability and Risk Assessment  
Rockville, MD  
December 19, 2007**

- Proposed Agenda –

Cognizant Staff Engineer: Hossein Nourbakhsh (301-415-5622, hpn@nrc.gov)

	<b>Topic</b>	<b>Presenter(s)</b>	<b>Time</b>
	Opening Remarks and Objectives	George Apostolakis, ACRS	8:30 am-8:40 am
I	Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking	Mary Drouin, RES Gareth Parry, NRR	8:40 am-10:30 am
	Break		10:30-10:45 am
II	Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking (Continued)	Mary Drouin, RES Gareth Parry, NRR	10:40am- 12:00pm
	Lunch		12:00-1:00 pm
III	Guideline for the Treatment of Uncertainty in Risk-Informed Applications	Ken Canavan, EPRI Doug True, EPRI Dan Vanover, EPRI	1:00-3:00 pm
	Break		3:00-3:15 pm
IV	Discussion		3:15-4:00 pm
	Adjourn		4:00 pm

**Notes:**

- Presentation time should not exceed 50% of the total time allocated for a specific item.  
Number of copies of presentation materials to be provided to the ACRS - 25.

**Advisory Committee on Reactor Safeguards  
Subcommittee on Reliability and Risk Assessment  
Rockville, MD  
December 19, 2007**

- Status Report -

**PURPOSE**

The Subcommittee will discuss the draft NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking."

**BACKGROUND AND DISCUSSIONS**

Probabilistic Risk Assessment (PRA) is increasingly being used as an important element in regulatory decisionmaking. U.S. Nuclear Regulatory Commission (NRC) is moving towards an expanded use of PRAs in what is termed risk-informed regulatory approach. In 1995, the NRC adopted a policy that promotes increased use of probabilistic risk analysis in all regulatory matters to the extent supported by the state-of-the-art to complement the deterministic approach. In the 1995 policy statement on the use of PRA methods in nuclear regulatory activities [1], the Commission notes that the "treatment of uncertainty is an important issue for regulatory decisions."

Various classifications of uncertainty have been reported in the literature. Two major groups of uncertainty that have been recognized are aleatory (or stochastic) and epistemic (or state-of-knowledge) uncertainty. The aleatory uncertainty arises from many stochastic events or phenomena that probabilistic models are adopted to describe their occurrences. This aspect of uncertainty is built into the structure of the PRA model itself. The epistemic uncertainty is attributed to uncertainty arising from how well the PRA model represents the actual system being modeled. The key distinction between these two types of uncertainty is that the aleatory uncertainty is, by definition, irreducible. The epistemic uncertainty, on the other hand, can be reduced by further study.

There are two classes of epistemic uncertainty that impact the results of PRAs: parameter uncertainty and model uncertainty. Parameter uncertainties are those associated with the values of the fundamental parameters of the PRA model, such as equipment failure rates that are used in quantifying the accident sequence frequencies. Most of the PRA codes have the capability to propagate the distribution representing uncertainty on the basic parameter values to generate a probability distribution on the results of PRA. NUREG/CR-6823, "Handbook of Parameter Estimation for Probabilistic Risk Assessment," provides guidance on methods for estimating the parameters used in PRA models and for quantifying the uncertainties in the estimates.

Model uncertainty reflects the limited ability to accurately model the specific events and phenomena used in the development of the PRA model. Examples include approaches to modeling human performance during accidents and models used for evaluating severe accident phenomena in level 2 PRAs.

Completeness can also be considered as one aspect of model uncertainty. Completeness uncertainty arises from the fact that not all contributors to risk are addressed in PRA models. Some contributors are not addressed because methodology for their analyses has not yet been developed. For example, the influences of organizational performance cannot now be explicitly modeled in PRAs.

ACRS has always emphasized the improvement of PRA scope and quality, including the treatment of uncertainties, and the impact of such improvements on the integrated decisionmaking process that utilizes risk information. In an April 21, 2003 report on Draft Guide 1122 (now RG 1.200), "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," the ACRS noted that a systematic treatment of uncertainties should include rigorous analyses for parametric uncertainties, sensitivity studies to identify the important epistemic uncertainties, and quantification of the latter. The Committee further noted that in a risk-informed environment, the proper role of sensitivity studies is to identify what is important to the results, not to replace uncertainty analyses.

The issue of PRA uncertainties was also addressed in a May 16, 2003 ACRS report on improvement of the quality of risk information for regulatory decision-making [2]. The Committee stated, "The assessment of uncertainties should address model uncertainties" and "guidance for the quantitative evaluation of model uncertainties should be developed." The Committee further noted, "More guidance regarding sensitivity and uncertainty analyses would contribute greatly to confidence in risk-informed regulatory decisionmaking." Such guidance "should address not only how uncertainties should be treated in the PRA, but also, how they impact decisionmaking with examples to show the pitfalls if uncertainties are inadequately addressed."

In response to the ACRS, the staff agreed that guidance is needed on the treatment of uncertainties in risk-informed decision making. The draft NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking," is intended to provide the needed guidance recommended by the ACRS. Electric Power Research Institute (EPRI), in parallel with the NRC, has been developing guidance documents on the treatment of uncertainties. This work is meant to complement the guidance provided in NUREG-1855. Where possible the NUREG-1855 refers to the EPRI work for acceptable treatment of uncertainties. The staff position on EPRI guidance documents on treatment of uncertainties in risk-informed regulatory applications (Appendix A to NUREG-1855) yet to be developed.

Draft NUREG-1855 focuses on fostering an understanding of the uncertainties associated with PRA, the impact of such uncertainties on the results of the PRA, and the uncertainties in the context of the decision making. However, the report is not clear on the pitfalls if uncertainties are inadequately addressed in a risk-informed application.

Draft NUREG- 1855 (page 3-8) defines model uncertainty as "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)." On the other hand, the report also states (page 3-10) that "one approach to dealing with a specific model uncertainty is to adopt a consensus model, which essentially removes that uncertainty from having to be addressed in the decision making." In the context of regulatory decision making, Draft NUREG-1855 defines a consensus model (page 3-10) as: "in the most general sense, as a model that has a publicly available published basis and has been peer reviewed and widely adopted by an appropriate stakeholder group. In addition, widely accepted PRA practices may be regarded as consensus models.....For risk-informed regulatory decisions,

the consensus model approach is one that the NRC has utilized or accepted for the specific risk-informed application for which it is proposed.” Both the definition for the model uncertainty and the approach to dealing with specific model uncertainty through adopting a consensus model may be questionable. Adopting a consensus model cannot account for synergistic effects that are plant specific. In addition, adopting a consensus model instead of addressing the uncertainty in the context of specific decision discourages any further study in reducing such uncertainties.

Various approaches for treating model uncertainty range from the mathematical to the expert judgment. Mathematical approaches, for example, include introducing a knowledge-based model uncertainty parameter into the model and treating this parameter in the same way as other uncertain parameters in PRA. The use of expert judgment may become necessary when there is a lack of complete understanding of the underlying fundamental mechanisms. This may include the structure of the model as well as uncertainty concerning the quantification of the variables involved [3]. The report does not provide any guidance on using expert elicitation in addressing model uncertainties.

## REFERENCES

1. U.S. Nuclear Regulatory Commission, “Final Policy Statement on Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities,” August 16, 1995.
2. Report dated May 16, 2003, from Mario V. Bonaca, Chairman, ACRS, to Nils J. Diaz, Chairman, U.S. Nuclear Regulatory Commission, Subject: Improvement of the Quality of Risk Information for Regulatory decisionmaking.
3. Nourbakhsh, H.P., “Assessment of Model Uncertainties In Regulatory Decisions Involving PRA Results,” Presented at the *International Topical Meeting on Probabilistic Safety Analysis, PSA’05*, San Francisco, California, September 11-15, 2005.

## SUBCOMMITTEE ACTION

The Subcommittee should be prepared to provide its views and recommendations to the Full Committee, at the March meeting. The Committee is expected to write a letter on Draft NUREG-1855 at that time.