

April 9, 2015

MEMORANDUM TO: William Dean, Director
Office of Nuclear Reactor Regulation

Dan Dorman, Regional Administrator
Region I

Gary Holahan, Deputy Director
Office of New Reactors

Steven West, Deputy Director
Office of Nuclear Regulatory Research

Brian McDermott, Deputy Director
Office of Nuclear Security and Incidence Response

Scott Moore, Deputy Director
Office of Nuclear Material Safety and Safeguards

Brian Holian, Deputy Director
Office of Nuclear Reactor Regulation

THRU: Sunil Weerakkody, Chief */RA/*
PRA Operations and Human Factors Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

FROM: Fernando Ferrante, Reliability and Risk Analyst */RA/ D. Copeland for/*
PRA Operations and Human Factors Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

SUBJECT: REVIEW OF THE NUCLEAR ENERGY INSTITUTE WHITE
PAPER ON TREATMENT OF UNCERTAINTY IN RISK-
INFORMED DECISION MAKING BY THE NUCLEAR
REGULATORY COMMISSION RISK-INFORMED STEERING
COMMITTEE WORKING GROUP

Purpose

The purpose of this memorandum is to convey the results of the review of the Nuclear Energy Institute (NEI) White Paper (Enclosure #1) on the Treatment of Uncertainty in Risk-Informed

CONTACT: Douglas Copeland, NRR/DRA
(301) 415-1246

Decisionmaking by the Nuclear Regulatory Commission (NRC) Risk-Informed Steering Committee's (RISC) Working Group (WG). In summary, the NRC's Working Group agrees with the recommendations in Enclosure #1. The NRC Working Group, however, disagrees with the manner in which some issues pertaining to the treatment of uncertainty and the benefits of risk-informed activities are characterized. The context and results of the NRC WG review, as well as key issues in the characterization of the treatment of uncertainty from an NRC perspective, are provided in this memorandum.

Background

The NRC RISC and the NEI RISC are comprised of counterpart senior management from NRC and NEI, respectively, and were formed in October 2013 to advance the use of risk-informed decisionmaking (RIDM) in licensing, oversight, rulemaking and other regulatory areas. The NRC RISC charter is available in Agencywide Documents and Management System (ADAMS) via Accession Number ML14178B004. As a result of discussions between these two separate RISCs, the NRC RISC directed the formation of two NRC WGs. Concurrently, NEI formed two counterpart WGs to interface on specific technical and regulatory aspects. This memorandum pertains to the activities related to the NRC and Industry WGs tasked with discussing the treatment of uncertainty in RIDM (the activities of the other NRC and Industry WGs will be discussed in a separate memorandum). Since the formation of the NRC and Industry WGs on uncertainty in RIDM, a number of interactions took place between the two WG through public meetings to accomplish the following objectives:

- Identify the specific causes for not being able to address uncertainties in current risk-informed applications in an efficient or effective manner.
- Evaluate current approaches to addressing uncertainties in risk-informed decisionmaking and identify any gaps that need to be resolved.
- Propose enhancements to the existing framework for addressing practical aspects of the treatment of uncertainty in risk-informed decisionmaking.
- Identify potential education mechanisms for both PRA practitioners and broader audiences, with respect to the treatment of uncertainty in decisionmaking.

As agreed to by the NRC WG, the NEI WG developed a set of recommendations based on the outcome of the related public meeting which included individual discussions, a tabletop exercise, and a workshop. In addition, a session in the NRC's 2015 Regulatory Information Conference (RIC) was held on the treatment of uncertainty in RIDM, which included a discussion of the activities of the NRC and Industry WGs. Enclosure #2 provides the list of public meetings and the associated meeting summaries and presentations.

The NEI WG conveyed the set of recommendations via a White Paper, which is the subject of the review discussed herein. Hence, the objective of this memorandum is two-fold: (1) to discuss the product of the NRC WG review of NEI White Paper, including an evaluation of the recommendations, and (2) to provide the NRC WG's suggested path forward to the NRC RISC on these recommendations. The most recent version of NEI White Paper is included as Enclosure #1 and is publicly available in ADAMS via Accession Number ML15062A118.

Overall Review Results

The NRC WG agrees with the recommendations articulated in the NEI White Paper. More specifically, the NEI White Paper provides the following recommendations:

1. Clarify Expectations for the Treatment of Uncertainty
2. Provide Guidance on Risk Aggregation
3. Develop Guidance on Integrating PRA Results into a Decisionmaking Framework
4. Develop Additional Guidance on Addressing Specific Challenges
5. Provide Guidance on Addressing Mitigating Strategies in RIDM
6. Conduct Annual Industry-NRC meetings on RIDM
7. Provide Education for Practitioners on Current Guidance
8. Provide a Training Course on RIDM and the Role of Uncertainty

Each recommendation includes a discussion of the specific context and subject involved, as well as possible follow-up actions on the corresponding recommendation. The NRC WG has reviewed these recommendations and agrees with them. Several of the recommendations relate to on-going efforts by the NRC. In summary, the objectives established for the NRC WG on the treatment of uncertainty in RIDM were met. The specific actions for a path forward based on the above recommendations are discussed next.

Path Forward

The NRC WG suggests further pursuing the following activities based on the activities mentioned above, its review of the NEI White Paper, and its evaluation of the on-going NRC activities in these areas. The recommendations are organized following the NEI WG scheme to indicate points of consistency and departure.

Recommendation 1: Clarify Expectations for the Treatment of Uncertainty

The NRC has recently completed Revision 1 of NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making." As part of the public interactions, a discussion on the timeliness of the release of this new revision was held. The NRC WG has recommends that this revised NUREG be immediately released to help address specific aspects of the treatment of uncertainty in RIDM, as well as serve as a vehicle for further discussions captured in the NEI White Paper. As part of this activity, the NRC WG also suggests the following:

- Perform a "pilot" of NUREG-1855, Revision 1, using one or more examples of risk-informed decisions either prior to or shortly after issuance of Revision 1. A "pilot" here refers to something less than a formal pilot of an actual application, but more than just a tabletop exercise, in order to exercise the practical implementation of the guidance in NUREG-1855, Revision 1.
- Based on the NUREG-1855, Revision 1, "pilot," consider how additional enhancements and modifications should be included in a future revision of NUREG-1855.

- The NRC's Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," includes specific references to NUREG-1855 as providing further guidance on the treatment of uncertainty in risk-informed decisions using a probabilistic risk assessment (PRA). The NRC WG recommends considering how to incorporate some of the main guidance from NUREG-1855, Revision 1, into RG 1.174 after the activities described in the first two list items are completed.
- NUREG-1855 contains significant guidance on the topic of treatment of uncertainty in RIDM. The NRC WG, which is comprised of staff from licensing, oversight, and research, recognizes that this guidance should be propagated through other NRC documents. For example, the NRC is planning to update specific guidance in relevant Inspection Manual Chapters (IMCs) with respect to RIDM for oversight activities that include consideration of uncertainties. In particular, guidance on RIDM when faced with significant irreducible uncertainties, as well as qualitative RIDM aspects are the subject of specific IMCs related to the Significance Determination Process (SDP). Such documents can be augmented with insights from NUREG-1855 and other activities stemming from the NRC and NEI WG interactions. More generally, the NRC WG recommends implementing changes in relevant NRC documents that enhance and clarify the practical aspects of the treatment of uncertainties in RIDM.

Recommendation 2: Provide Guidance on Risk Aggregation

The subject of "Risk Aggregation" (i.e., the consideration of multiple hazards and their aggregated results within PRA) was brought up in multiple discussions. The NRC WG recommends consideration of additional activities evaluating both the technical and regulatory aspects of "Risk Aggregation." The technical aspects include the consideration of the quality and completeness of the information concerning the risks of different hazard groups (e.g., internal events versus external events). The regulatory aspects include RIDM as affected by situations where the aggregation of risk results from multiple hazards indicate that the overall PRA results challenge the NRC's subsidiary safety goals for core damage frequency (CDF) and large early release frequency (LERF) or other associated application-specific acceptance guidelines. One of the options recommended in the NEI White Paper was the sharing of on-going Electric Power Research Institute (EPRI) work on this subject. The NRC WG recommends that the NRC RISC consider additional activities in this area, including research activities in the technical aspects as well as additional NRC and Industry WGs to evaluate the regulatory issues. Recognizing that the Industry's ongoing efforts in this area may provide significant technical contributions to the NRC's own efforts, the NRC WG also recommends that the NRC RISC support technical coordination with Industry in this area.

Recommendation 3: Develop Guidance on Integrating PRA Results into a Decisionmaking Framework

The NEI White Paper includes a recommendation to integrate the PRA results in RIDM, and points to several documents (e.g., IMC0609 Appendix M, "Significance Determination Process Using Qualitative Criteria" and NRR's Office Instruction LIC-504, "Integrated Risk-Informed Decision Making Process for Emergent Issues") that are used for specific applications. The NRC WG staff agrees that consistency in the treatment of uncertainty is important and that the NRC's current guidance on the subject should be as consistent as possible, recognizing the

different intents of these different processes. Implementation of the NRC WG's aforementioned recommendation on the incorporation of the guidance in NUREG-1855, Revision 1, into RG 1.174 would further promulgate the overarching guidance that would be considered for the specific purposes of RG 1.174. Ultimately, specific applications (e.g., licensing, oversight) would require separate guidance, but the NRC WG recognizes the need for consistency with fundamental guidance documents such as NUREG-1855, Revision 1, as well as with future changes. The NRC WG, therefore, recommends that the NRC RISC consider providing direction to the individual process owners of the various NRC guidance documents and that relate to the treatment of uncertainty in RIDM to coordinate their activities to ensure that their implementations of RIDM concepts are appropriately consistent.

Recommendation 4: Develop Additional Guidance on Addressing Specific Challenges

One important topic addressed during NRC and NEI WG discussions involved RIDM when faced with very large, irreducible uncertainties. In particular, one recognized challenge was the assessment and treatment of the uncertainties associated with analyses of specific external hazards, including severe external flooding. The NRC is planning to perform research activities in this area that could enhance and support better RIDM. The NRC WG recommends that the NRC RISC support efforts to enhance current guidance based on the output of these research activities, as well as any other efforts that may enhance the understanding of the technical aspects related to addressing the uncertainty associated with external hazards and events.

Recommendation 5: Provide Guidance on Addressing Mitigating Strategies in RIDM

The topic of Mitigating Strategies in RIDM was raised as a correlated subject to the treatment of uncertainty. While this topic has wider implications beyond the scope of the NRC and NEI WGs, it is recognized that analysis uncertainties may play a significant role in crediting plant-specific mitigating strategies in PRAs. For example, the consideration of uncertainty in external events, mentioned above, could impact RIDM when mitigating strategies are involved. It is also worth noting that an effort to develop guidance on SDP evaluations for mitigating strategies is already under development. The NRC WG suggests that an effort be initiated to address the treatment of mitigating strategies within PRA. Recognizing that the Industry efforts in this area may also provide significant technical contributions to the NRC efforts, the NRC WG also recommends that the NRC RISC support the technical coordination with Industry in this area.

Recommendation 6: Conduct Annual Industry-NRC meetings on RIDM

One of the NEI recommendations includes consideration of an annual Industry-NRC meeting on RIDM. The NRC WG agrees with this recommendation and recommends the initiation of interactions with Industry on how to organize this activity.

Recommendation 7: Provide Education for Practitioners on Current Guidance

The NRC WG recommends that NRC and Industry evaluate the need for a joint NRC-Industry workshop on NUREG-1855, Revision 1, to help practitioners understand the expectations if the guidance and other relevant documents. It is anticipated such a workshop could be similar to the workshop that was held when Revision 0 of NUREG-1855 was published.

Recommendation 8: Provide a Training Course on Risk-informed Decision-making and the Role of Uncertainty

Specific tasks related to communication and training activities were discussed as part of the objectives of the NRC and NEI WGs. An initial review by the NRC WG indicates that significant training exists but that it is usually geared towards providing: (1) detailed technical information for risk practitioners, or (2) a brief overview of PRA concepts for non-practitioners. In these areas, the NRC WG recommends:

- Evaluation of current training and communication tools with respect to treatment of uncertainty in RIDM, such that both practitioners and non-practitioners can become better prepared to discuss and communicate important aspects in this area.
- If the recommended evaluation reveals that the current training and communication tools are inadequate, then, additional internal NRC staff training should be developed and implemented based on the guidance stemming from NUREG-1855, Revision 1, and other documents. Joint training with Industry may also be developed, similar to the on-going periodic EPRI-NRC Fire PRA training courses.

Additional NRC WG Comments on the NEI White Paper

While the NRC WG agrees with the overall NEI WG recommendations and options, it also believes that the manner in which some of the issues were described in the NEI White Paper overlooks many advances that have been made in the treatment of uncertainty in RIDM. The manner in which PRA modeling and RIDM have been characterized in the NEI White Paper could be inferred to question the ability of the NRC to make sound risk-informed regulatory decisions due to uncertainties.

The NRC WG believes and feels it is important to acknowledge that the NRC has the ability to make sound risk-informed decisions, while recognizing the various uncertainties in PRA. In reading the issue description in the NEI White Paper, one could infer initially that both the guidance and standards must be flawed to have these issues and/or that no one is following the existing guidance. The NRC WG observes that recently issued and upcoming guidance developed by both the NRC and Industry further addresses and improves the consideration of uncertainties in RIDM. A clear example of this is the soon-to-be published Revision 1 of NUREG-1855, which includes guidance that has not been used in applications. While this guidance can certainly be improved, it should be recognized that significant efforts have been expended in this area and that significant progress has been made in practical implementation.

The NEI White Paper, when discussing the current status and nature of PRA models, states that biases and the lack of mature consensus methods for external events is a driver in the challenges associated with the treatment of uncertainties. The NRC WG does not agree that this is a matter of maturity. Larger uncertainty associated with the external hazards, as compared to the internal events, is primarily due to the uncertainty (and randomness) in the hazard itself. The NRC WG further notes that, considering the indicators of a mature analysis technology, it is arguable whether the analysis of external hazards is as immature as often stated. For example, indicators include the availability of agreed upon analytical frameworks, research efforts being driven by application needs, and use in practical decisionmaking. The existence of uncertainties by itself is not a measure of maturity. It is important to recognize that

the historical development of external events PRAs has been concurrent with internal events PRAs. Early examples include NUREG-75/014 (WASH-1400), "An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants" (1975), major industry PRAs (e.g., Zion and Indian Point) in the 1980s, and NUREG/CR-2300, "PRA Procedures Guide: A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants" (1983).

With respect to the wider application of PRA, the biases and conservatisms discussed in the NEI White Paper could be misconstrued to imply that PRAs are generally overly conservative, when such biases can also be non-conservative as well. The characteristics and limitations of PRAs are important to identify and communicate to decisionmakers. However, efforts should not be solely focused on the qualitative assessment of PRA credit when perceived biases are included, but instead should be focused on the evaluation of the more central issue of the technical adequacy and appropriate uncertainty treatment for some of the challenges identified in the NEI White Paper. Ultimately, if a hazard or issue is potentially significant to a risk-informed decision, then it should be addressed in a PRA following the existing guidance that is used for risk-informed regulatory actions.

Also, the issue of overconservatism (as opposed to realism) can be overstated if the presentation of risk profiles is not appropriately characterized (i.e., too much emphasis on relative insights). For example, the fact that there is one dominant contributor in a risk profile does not mean others can be ignored. Similarly, risk importance measures typically used in PRA are relative, so the dominance of one conservative contributor can give the impression that others are insignificant. Again, the appropriate balance between absolute and relative insights should be presented to the decisionmakers to (1) avoid the implication that all PRA assumptions are conservative *a priori*, thereby propagating a misperception of the use of PRA in decisionmaking; and (2) avoid conveying that conservatism automatically skews risk profiles or importance measures since this depends on the nature of the profile or importance measure.

Conclusion

The NRC and NEI WGs successfully participated in activities to identify specific challenges, gaps, and enhancements needed in the treatment of uncertainty in RIDM. The NEI WG developed a set of recommendations based on public meeting discussions, tabletop exercises, and a workshop. The NRC WG provided feedback on those recommendations. The NEI WG White Paper incorporates, in part, some of the NRC WG observations and commentary. Although some of the NRC WG comments were not included in the NEI white paper, the NRC WG agrees with the industry-recommended follow-up actions identified in Recommendations 1-8.

The NRC WG recommends that the NRC RISC consider the activities of this WG complete and transfer the proposed recommendations to the appropriate NRC program offices.

Enclosures:

- 1) White Paper: NEI Risk-Informed Steering Committee Uncertainty Working Group, Dated February 17, 2015 (ML15062A118)
- 2) Summary of Public Meetings

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OFFICE	NRO/DSRA	NRR/DRA/APLA	RES/DRA/PRB	NRR/DIRS/IPAB
NAME	DHarrison*	RGallucci*	MDrouin	SVaughn*
DATE	3/25/2015	3/25/2015	4/6/2015	3/26/2015

OFFICE	RES/DRA/PRB	RES/DRA	NRR/DRA/APHB	NRR/DRA/APHB
NAME	AGilbertson*	NSiu*	DCopeland	FFerrante*
DATE	3/26/2015	3/27 /2015	3/25/2015	3/26/2015

OFFICE	NRR/DRA/APHB
NAME	SWeerakkody
DATE	4/ 09 /2015

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Summary of Public Meetings

- NRC and NEI RISCs Public Meeting on February 7, 2014 (Summary) Agencywide Documents Access and Management System (ADAMS) Accession Number ML14057A519.
- Public Meeting between NRC and NEI Working Groups on August 6, 2014 (Summary) ADAMS Accession Number ML14247A433, (Presentation) ADAMS Accession Number ML14216A061.
- NRC and NEI RISCs Public Teleconference on September 29, 2014 (Summary) Accession Number ML14275A209, (Presentation Accession Number ML14273A203.
- Public Meeting between NRC and NEI Working Groups on October 16, 2014 (Summary) Accession Number ML14300A386, (Presentations) Accession Number ML14290A205, ML14290A192, ML14290A189, ML14290A197, ML14290A195.
- NRC and NEI RISCs Public Teleconference on October 30, 2014 (Summary) Accession Number ML14309A230, (Presentation) Accession Number ML14304A433.
- Public Meeting between NRC and NEI Working Groups at Workshop on November 20, 2014 (Summary) Accession Number ML14343A784 and (NEI Workshop Presentation) Accession Number ML14324A630.
- NRC and NEI RISCs Public Meeting on December 17, 2014 (Summary) Accession Number ML15009A139.
- Public Meeting between NRC and NEI Working Groups on February 5, 2015 (Summary) Accession Number ML15041A372.
- NRC's Regulatory Information Conference (RIC) 2015, Session T6 "Treatment of Uncertainty in Risk-Informed Decisionmaking", <http://www.nrc.gov/public-involve/conference-symposia/ric/>.
- Public Meeting between NRC and NEI Working Groups on March 24, 2015 (Meeting Notice) Accession Number ML15072A127.