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Conceptual Example of a Proposed Risk Management Regulatory Framework Policy Statement

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General Comment

See attached file(s)

Attachments

Response to FRN on RMRF_2-2014

Response to NRC-2013-0254-0004 from N. Prasad Kadambi Ph.D. P.E.

I am responding to the invitation to comment as an ex-employee of the USNRC who worked on the subject matter of the Federal Register Notice and conducted research on the issues addressed therein. I am concerned that relevant work that was done on behalf of the NRC may get ignored, resulting in wastage of valuable resources. I offer what follows gratefully acknowledging the contributions of Dr. Robert Youngblood including some in private communications.

The FRN NRC-2013-0254-004 is meant to be an extension of NRC-2013-0254-0001 which had a plethora of questions regarding a proposed risk management regulatory framework. The two FRNs, taken in combination with the public meeting on January 30, 2014, create much confusion regarding the nature of this comment solicitation. It is unclear whether or not the NRC staff is proposing two separate policy statements, one on a risk management framework and a different one on defense-in-depth. It is my intention to address each subject area separately in what follows.

Identification of Relevant Reports:

It is stated within NRC-2013-0254-0002, "The NRC's regulatory program has evolved considerably over time, incorporating such concepts such as defense in depth and performance based regulation, and with methods such as probabilistic risk assessment representing important aspects of this evolution." I see a possible implication here that the concept of performance based regulation does not have methods developed to the extent that is associated with PRA. Methods development for performance based regulation has been advanced quite significantly by NRC's own funding. However, it remains to be recognized that methods development regarding performance based regulation is on par with that associated with PRA. Three of the reports I refer to below offer evidence to this fact.

NUREG/CR-5392, "Elements of an Approach to Performance-Based Regulatory Oversight"

This report discusses the key issue in developing a performance-based approach, which is choosing a collection of performance measures that is highly results-oriented, and will support the capability to detect and act upon emerging performance problems before they lead to adverse consequences.

NUREG/CR-6833, "Formal Methods of Decision Analysis Applied to Prioritization of Research and Other Topics"

Formal methods are employed as part of institutionalization of decision-making so that accountability can be established between decisions and outcomes. Clearly this would improve the existing NRC regulatory framework, and would appear to be a necessary part of one that includes pursuit of risk management in a formal sense.

NRC makes decisions that are based on assigning priorities to issues. Prioritization is a special case of general decision analysis and many of the tools and ideas that apply to prioritization apply much more broadly to agency decision-making. Factors that complicate decision-making in many cases, and drive the need for formal approaches, is uncertainty regarding the probabilities and consequences of various outcomes

associated with decision alternatives. Treatment of uncertainty, and the formulation and application of a structured approach, is important not only to making actual decisions, but also in many supporting activities that are not necessarily explicitly formulated as "decision-making" even though they entail setting priorities and making choices. Investment in research becomes very important when decisions are considered in such a framework. Reduction of significant technical uncertainties should be a key driver for research prioritization. One of the important areas covered by NUREG/CR-6833 is "Value of Information," a concept that relates the potential worth of a research program to the effect of the subject uncertainty on agency decisions. It then proceeds to address the need for a considered formulation of the fundamental and means objectives that the decision-maker would need to address. This requires a clear definition of goals and objectives in a hierarchical structure, and explicitly presents all objectives whether qualitative or quantitative.

Another important area that NUREG/CR-6833 addresses is to answer the question, "What is the potential likelihood and what are the resulting consequences of being either right or wrong about a decision criterion that has been set in respect of a particular issue?" This is a more generalized formulation of risk management and a better approach than focusing on building better PRAs.

SECY-2005-0138, "Risk-Informed and Performance-Based Alternatives to the Single-Failure Criterion"

The most pertinent part of this Commission paper is the enclosed technical report supporting evaluation of a broader change to the single-failure criterion (SFC). This work has significant relevance in the context of a risk management regulatory framework that is risk-informed and performance-based in its approach. The current implementation of the SFC requires redundancy of safety systems that respond to design-basis events. Redundant system design, along with application of independence and diversity of appropriate elements, are parts of defense-in-depth, and serve as surrogates for system reliability. This has been pointed out by commenter Steven Mays (NRC-2013-0254-0005) as well.

Surrogates are employed when it is impractical to directly model performance measures that accurately reflect the degree of attainment of the particular objective. Current abilities to model risk make it possible to obtain better assessments of the attainment of objectives. The PRAs for operating power plants incorporate these assessments based on prescriptive requirements to consider the most limiting single-failure. Inefficiencies in the regulatory process have occurred because new information may surface during operation regarding the most limiting single-failure. Occasionally, this leads to findings of non-compliance with regulatory requirements even if the safety significance may be low. Applying the results of SECY-2005-0138 as part of an integrated regulatory framework for new plants may improve regulatory efficiency and effectiveness for them. Also, these results would benefit the broader application of SFC to risk management in all other areas of NRC scope within a comprehensive regulatory framework.

A Risk Management Regulatory Framework:

It is necessary to clearly distinguish a generally applicable risk management regulatory framework from an application of such a framework to implement defense-in-depth strategies. The White Paper in NRC-2013-0254-0002 lacks such a distinction. As a

result there is no discernible architecture that characterizes the proposed regulatory framework. It may be helpful to think of the framework as the interior structure of the box labeled "Integrated Decision-Making" that appears in Figure 2 of Regulatory Guide 1.174. The structure could then be envisioned to apply as appropriate to each of the factors in Figure 2, which are safety margins, defense-in-depth, conformance with regulations, performance measurement and monitoring, and changes to risk metrics. The expectation is that the outcome of conducting the regulated activities would be consistent with results of the integrated decision-making in an accountable way.

A key part of the integration that needs to occur related to integrated decision-making is between the "deterministic" aspects and the "probabilistic" analyses. Discussion in recent years has stressed the point that risk analysis is needed in order to provide a kind of safety perspective that has not been obtained from traditional design-basis analysis alone. Both regulators and licensees need a risk-informed perspective in order to set priorities in an optimal way, but risk analysis cannot provide a complete substitute for traditional engineering analysis.

The traditional "deterministic" approach should be integrated into the structure of a risk management regulatory framework. This should be done within a risk-informed process that determines the scope and stringency of regulatory requirements. Regulatory requirements need to be explicit so that licensees know where they stand on matters of compliance in the conduct of daily operations. Also, there needs to be clarity regarding what they can and cannot change in their plants without regulatory approval. This calls for a level of specificity, objectivity and verifiability that is best obtained from classical engineering analysis. This is not to say that the requirements should be classically prescriptive, or derived from a suboptimal class of surrogate postulated accident scenarios. Regulatory requirements can be more performance-based (less prescriptive) than today's requirements, and a suitable basis for the requirements will include risk analysis. However, rather than trying to solve the inverse problem in a single step (i.e., starting with an acceptable risk profile and directly deriving practical engineering requirements), it will be useful to formulate a high-level set of functional performance requirements from a comprehensive risk model, and then derive practical engineering requirements from those high-level functional requirements. The practical engineering requirements would thereby be tied to (derived within) a comprehensive risk perspective. All of this can be addressed as part of a comprehensive safety case. Most elements of today's practice can be placed into correspondence with this idea. Implementing it over the entire safety case (rather than piecemeal), would provide an opportunity to address many of today's issues in an integrated way.

A reasonable expectation from such an integrated decision making approach would be that overall regulatory uncertainty faced by applicants and licensees would decrease. Reduction of regulatory uncertainty should be a fundamental objective for the objectives hierarchy within the risk management regulatory framework. Such an approach would be entirely consistent with the strategies articulated by the NRC, the principles of good regulation and the proposals and recommendations in NUREG-2150.

A Policy statement on Defense-in-Depth:

I support a broad-scope Commission policy statement on defense-in-depth and the sunsetting of the PRA policy statement. As defined by the Commission, the policy would cover everything from preventing faults from occurring to the interface with local, state

and federal activities related to emergency planning and preparedness. A policy of such scope requires an over-arching organizing concept to provide unification, integration and harmonization. Otherwise, it may never be possible to reach a conclusion regarding how much defense-in-depth is enough.

Principles of analogy can be usefully employed here, borrowing from biological systems. The ecology of biological systems is sometimes characterized by a property of "resilience", which is the capability to absorb disruption and recover a level of acceptable performance that can be sustained for a period of time. Systems that use and apply radiological materials could include software, hardware, humans, concepts, and processes. The idea of "resilience" has been adopted as policy at the federal level in Presidential Policy Directive (PPD-21, 2013) on Critical Infrastructure Security and Resilience. In the context of a nuclear power plant, resilience would equate with, among other things, the positive contributions to safety by effective organizational factors, including the safety culture. Incorporating radiological defense-in-depth into a larger context, such as the concept of resilience, would make it easier to communicate the balancing of values that is important to decision-making. There would likely also be practical benefits in respect of the NRC fulfilling its assigned responsibilities in PPD-21.