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Comment On: NRC-2019-0062-0012
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General Comment

Please consider and provide feedback on the comment input that I have submitted in the attached file named, "Comment Input to Part 53_12-31-2020". My qualification for submitting this input is that I am the primary author of NUREG/BR-0303, "Guidance for Performance-Based Regulation". NUREG/BR-0303 is included as a reference in the Part 53 rulemaking, but stakeholders are not provided sufficient guidance regarding its significance. My hope is that my comment input will enable a better understanding of the capabilities associated with the methodology provided in NUREG/BR-0303.

N. Prasad Kadambi Ph.D. P.E.

Attachments

Comment Input to Part 53_12-31-2020

<u>Comment Input to NRC-2019-0062-0012</u>

"Preliminary Proposed Rule Language: Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors"

N. Prasad Kadambi Ph.D. P.E.

Retired from USNRC, Primary Author of NUREG/BR-0303, "Guidance for Performance-Based Regulation"

NRC staff should recognize that the structure of the provisions for the proposed 10 CFR Part 53 are amenable to be represented as specific performance objectives along the lines of NUREG/BR-0303, "Guidance for Performance-Based Regulation." This can be done just by adding appropriately worded text from Appendix B of NUREG/BR-0303 to the discussion sections of the proposed rule language. For example, there is need for clarity in the way AEA Sections 182 and 161 are to be addressed by an applicant under proposed Part 53, Subpart B, Section 53.20, "Safety Objectives". A formal objectives' hierarchy would more efficiently clarify that performance objectives under AEA Section 182 would not be allowed to consider cost as a factor in achieving reasonable assurance that each specific performance objective is fulfilled. However, performance objectives under AEA Section 161 would be allowed to invoke cost-benefit analysis to justify formulation of specific performance objectives. Under these objectives, satisfactory performance can be gaged using "reasonable confidence" as the measure of adequacy.

<u>Objectives' Hierarchy:</u>

An objectives hierarchy is a diagram representing the relationships and dependencies between goals, top-level fundamental objectives, lower-level fundamental objectives, and means objectives. Fundamental objectives are ends in themselves; means objectives are things that are desirable because they support fundamental objectives. An example of a goal is "protection of the health and safety of the public;" an example of a fundamental objective is "protection of the public from excessive radiological exposures;" and an example of a means objective is "reliability of safety systems."

With construction of an objectives' hierarchy, it becomes easier to assess the levels of performance needed from each element. Also, one can determine those cases in which performance can appropriately be monitored through inspections or performance indicators, and where it cannot.

A formally constructed objectives' hierarchy would enable:

1. allocation of performance across relevant functions, systems, or barriers, in order to assess whether the target safety objectives are satisfied;
2. implementation then of a process for allocation of performance which entails identifying the steps to be taken by licensees and/or NRC to make the performance allocation "come true" in practice. Part of implementation is confirmation of ongoing performance.

The performance-based approach to safety is best viewed as a safety decision-making framework. The framework begins with clarification of objectives with an objectives' hierarchy which lays out competing objectives such as those where consideration of costs may or may not be allowed. The costs to be considered may not occur only in monetary terms but as operational burdens that may complicate safety performance by over reliance on programmatic features in a design. Competing objectives can also arise due to consideration of occupational radiation exposures or consideration of safeguards versus safety. The objectives' hierarchy described in NUREG/BR-0303, Appendix B offers an example of transparent consideration of such factors.

NUREG/BR-0303, Appendix B also makes the case for clarifying objectives as being of a fundamental nature or as means objectives that support fundamental objectives in a manner similar to the proposed Part 53, Section 53.21, "Safety Functions". Section 53.21 (a) states that the primary safety function is limiting the release of radioactive materials. Section 53.21 (b) states that additional safety functions are to be defined that support the retention of radioactive materials, such as by controlling heat generation, heat removal, and chemical interactions. From a performance-based regulatory perspective, it appears unnecessarily prescriptive to identify limiting release of radioactive materials as being fundamental for all prospective advanced reactor technologies at this early stage of rulemaking. It may turn out that for some technologies, a different safety function is a better choice as the fundamental functional performance objective.

<u>Defense-in-Depth:</u>

Construction of an objectives' hierarchy as that described in NUREG/BR-0303, Appendix B facilitates assessment of defense-in-depth in a manner complementary to that offered in NEI 18-04 and endorsed in RG-1.233. In a formal performance-based approach, adequate coverage of key performance areas with performance measures can qualitatively address defense-in-depth considerations. Analogous to logic tree development, each level of the objectives' hierarchy is derived from the level above by decomposing each node into constituent elements. Each means objective relates to an objective above it on the hierarchy, in that it answers the question, "How is the higher-level objective to be accomplished?" (Question: How will safety function X be accomplished? Answer: By reliable function of systems A, B, and C.) In fact, a system reliability model developed hierarchically and expressed in "success space" is essentially a partial objectives hierarchy. It is "partial" because it addresses only safety performance, and because, even within safety, a logic model does not usually address cross-cutting programmatic issues.

The objectives' hierarchy construct described in NUREG/BR-0303, Appendix B employs the decision-making framework used in the NRC's Reactor Oversight Process (ROP). The ROP labels certain means objectives as being "cornerstones of safety" under the fundamental safety area of "Reactor Safety". The cornerstone areas identified are intended to be a complete set of key performance areas affecting safety. The key attributes identified within each cornerstone are likewise intended to be a complete set. Performance is expected in each cornerstone area. Strong performance in all areas provides an important defense-in-depth component, because to some extent, performance in one area can compensate for lack of performance in another. For example, an increase in initiating events frequency will not typically be a safety issue, if the mitigating systems' performance is satisfactory, meaning that there exists plenty of margin that can be monitored and validated.

Completeness is one of the reasons to pursue a systematic and formal development of an objectives' hierarchy. Consideration of the different cornerstone areas also illustrates how the implicit underlying allocation of performance addresses defense-in-depth at a high level. Balance between prevention and mitigation is shown by the presence of cornerstones addressing initiating events, mitigating systems, and emergency preparedness; the additional consideration of barrier integrity further reinforces defense-in-depth. It should be noted that the objectives identified down to the cornerstone level are all technology-inclusive. An advanced reactor project can develop an objectives' hierarchy that is the same, similar or quite different from that described in NUREG/BR-0303.

Life-Cycle Considerations:

The proposed 10 CFR Part 53 rule appears to adopt a different structure for its provisions than that which exists for 10 CFR Parts 52 and 50. Right from the outset, Subparts B, C, and F of the proposed rule are cast as a continuum which covers safety criteria, design and analysis, and operational safety including programmatic elements. Each of the subparts explicitly states that relevant considerations apply over the life of the facility. Hence, if carried through to finalization, 10 CFR Part 53 would represent an unprecedentedly integrated perspective for the promulgation of safety requirements for advanced reactors. Such an integrated perspective is ideally suited for implementation of a performance-based approach to specifying requirements that appropriately considers safety margins over various phases of the life cycle.

NUREG/BR-0303, Appendix B offers a high-level perspective on how a performance-based approach to formulating a safety case for an advanced reactor over its life cycle could be constructed. Recognizing that it is an applicant's responsibility to prepare the safety case, there would be a benefit for both the applicant and the NRC if the detailed discussion of the provisions of 10 CFR Part 53 regarding a specific design were conducted relative to a standardized objectives' hierarchy along the lines of NUREG/BR-0303, Appendix B. The performance objectives from the fundamental to cornerstones levels would remain relatively unchanged over the life cycle except that performance parameters would have different criteria associated with them at various stages. Such a standardized approach to the licensing process would likely be significantly more efficient than the current process. Potential litigation issues related to intervention in the licensing process could be transparently isolated for disposition in a way that may not be possible in the current process.