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10 CFR Part 53: Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors

Comment On: NRC-2019-0062-0012

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

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Comment on FR Doc # 2020-24387

Submitter Information

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General Comment

The use of epistemic and aleatory uncertainty adds unnecessary detail to the regulation. Unless there is a specific design decision that would be made depending on the nature of the uncertainty, it seems that they just add confusion. A detailed comment is attached.

Attachments

comment3

Comment on use of “Epistemic and aleatoric uncertainty” NRC-2019-0062

The comment

Words such as “epistemic,” “epistemology,” “aleatory,” or “aleatoric,” should not appear in regulation; such ideas may be meaningful in other contexts but, here, they add no useful context. Engineers well understand the use of factors of safety, redundancy, defense in depth all in accordance with good engineering practice, codes and standards, knowledge of test data, and regulatory requirements, to account for uncertainties. The language should be changed as indicated below.

§53.25 Defense in Depth. Measures must be taken for each advanced nuclear plant to ensure appropriate defense in depth is provided to compensate for ~~epistemic and aleatory~~ uncertainties such that there is high confidence that the safety criteria in this subpart B are met over the life of the plant. The ~~epistemic and aleatory~~ uncertainties to be considered include those related to the ability of barriers to limit the release of radioactive materials from the facility during routine operation and for licensing basis events and those related to the reliability and performance of plant SSCs and personnel, and programmatic controls. Measures to compensate for these uncertainties can include increased safety margins in the design of SSCs and providing alternate means to accomplish safety functions. No single design or operational feature, no matter how robust, should be exclusively relied upon to meet the safety criteria of 10 CFR part 53.

On the concern

This reviewer’s concern is that including the qualifiers on uncertainty adds classifications of uncertainty into regulation where there is no clear consensus on the demarcation or use of the terms; the literature on uncertainty, epistemology and aleatory distinctions is vast and confusing. Unless the distinction among types of uncertainty leads to clear application in protective design decision-making, the distinction is at best superfluous and at worst confusing.

Bibliography

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Reviewer background & statement on motivation

My experience extends to most nuclear power settings, US Navy nuclear operator (submarine service), fuel manufacture, national laboratory tests (LOFT program), and experience as Shift Technical Advisor, Unit Reactor Engineer, Probabilistic Risk Analyst at a large commercial PWR power station, and in academia, teaching undergraduate and graduate nuclear engineering courses and nuclear engineering research in university settings. Experience in nuclear power has led me to believe that careful regulation of nuclear power technology is absolutely essential, and that the Nuclear Regulatory Commission (the Commission), as it is has been designed to regulate following the Atomic Energy Act of 1954 (AEA), is certainly the most effective United States regulatory authority.

Motivation for this comment is that uncertainty is well understood in engineering practice and reliance on certainty in engineering physics and safety engineering principles is clear. Additional descriptions of uncertainty are not helpful to regulation of protective system design (technical specifications) unless it is made clear how they would change design decision-making. That is, simply stating that epistemic and aleatoric uncertainty must be accounted for in design provides no useful information about what different decisions would be made depending on either epistemology or aleatory uncertainty. Here is a problem that concerns me. Suppose a large data set is developed for a device’s lifetime as is done in reliability engineering and a distribution is fit to the data with uncertainty bounds and it turns out the uncertainty about the device’s lifetime can be expressed with a mean and standard deviation. Would the engineer responsible for a protective system design using this device wonder what parts of the uncertainty are epistemic and which parts are aleatoric? Or would she more likely understand that a safety margin must be added that ensures the uncertainty expressed by the standard deviation (in the appropriate direction) is taken into account? Let us say, without support, that the Commission believes the device uncertainty is strictly aleatoric and therefore the design should be acceptable as the

licensee's accounting of uncertainty and safety as described above is acceptable. Would that hypothetical scenario be acceptable? Perhaps the clever engineer knows an operator or a maintenance technician could cause the device to fail in service. Realizing this could happen, would she categorize the added uncertainty associated with these new sources as epistemic (or aleatoric) or would she simply design the protective system with defense in depth or other sources of safety margin to account for these scenarios as well? It seems that attempting to classify uncertainty simply adds unnecessary time and effort into protective system design.