DSI-12

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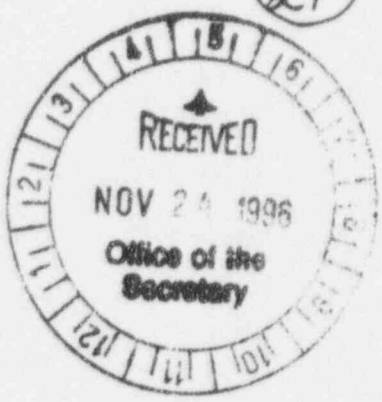

From: N. P. Kadambi <NPK@nrc.gov>
To: WND1.WNP2(secy)
Date: 11/24/96 5:05pm
Subject: COMMENTS ON DSI-12

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1. What considerations omitted?

   Please see enclosed file with comments.

2. Accuracy of NRC's assumptions and projections?

   Please see enclosed file with comments.

3. Commission's preliminary views?

   I support the Commission's inclination to adopt Option 3 on DSI-12.

COMMENTS IN ENCLOSED FILE

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The work on this DSI is intellectually stimulating and filled with challenging conundrums. I believe that the greatest achievement of this work is the attention given to defining some terminology such as deterministic and performance-based. I do not fully agree with all the definitions and the implications thereof. Hence, I offer the following comments:

(1) What is a deterministic approach?

The answer to this question must consider the meaning of "deterministic", which is rooted, I believe, in the philosophy of "determinism." The Oxford Dictionary identifies one meaning of "determinism" as "The doctrine that everything that happens is determined by a necessary chain of causation". After looking at other definitions of "determinism" as well, I interpret determinism (in the context of nuclear power plant regulation) as postulating "causes" and "effects" and relating them through analyses and engineering judgement. For every effect there is a necessary "chain of causation", giving rise to a one-to-one mapping of "cause" into "effect". In other words, there is no element of doubt anywhere in the chain between "cause" and "effect". In practice, if any doubt arises, it is removed by applying conservative assumptions.

This is how prescriptive regulation was born. In this reasoning, it is asserted that a condition adverse to safety (the effect) can be precluded by prescribing that the "cause" be eliminated. Requirements on containment leakage offer an example of this reasoning. The condition of concern is external release of radioactivity. The cause was leakage through penetrations. The original regulation prescribed that essentially no leakage be permitted. The revised regulation offers a different approach.
Conversely, a "cause" could be hypothesized based on postulation of all possible accidents and selecting a few that bound all others sufficiently in the judgement of decision makers. Engineering systems could then be prescribed that will keep the "effect" within tolerable limits. The double-ended guillotine break of the main coolant line (LOCA) is such a postulate. The tolerable effect is maintenance of cladding integrity.

The concept of defense-in-depth follows directly from building a framework of "maximum credible accidents" (which became design basis accidents) with conservatisms added on in the form of postulating failure even though design is supposed to prevent it, and mitigation of consequences of failure as the next layer of defense.

The deterministic approach has two distinctive sub-groups; the mechanistic approach and (to be contrasted with) the non-mechanistic approach. In the mechanistic approach, one usually works backwards from the effect that is to be precluded. An example of this concept is 10 CFR 50.49, the environmental qualification rule. The environmental conditions of the LOCA prescribed the testing conditions for the electrical equipment under this rule. In the non-mechanistic approach, one begins with a sufficiently enveloping cause to serve as the basis for design of systems. The non-mechanistic source term under TID-14844 is an example of such an approach.

In determinism, for every cause, there is a predictable and certain effect. Hence, a litmus test is applied to each situation and a conclusion is drawn whether it is "safe" or "unsafe". Every situation can only be one or the other. There is no graduated scale between "safe" and "unsafe".

How to treat "uncertainty?"

There is no room for uncertainty in determinism. For example, our regulations do not really consider uncertainty relative to reactor vessel integrity during design basis events because, if adequate core coolability is assured, the reactor vessel cannot be breached. Hence, breach of the reactor vessel is beyond the design basis and should not be considered in any decision making associated with the license of a nuclear power plant. If this does become an issue, the licensee can legitimately object that a basic understanding of the license has been changed unilaterally.

Consideration of uncertainty becomes relevant only if we accept "shades of gray" between "safe" and "unsafe". To me it appears as a glaring contradiction to want to treat uncertainty in a deterministic framework. Once one admits that there is uncertainty, one has to adopt a Probabilistic framework and throw out the deterministic framework. Of course, in practice this can only be done issue by issue for the current generation of reactors. Also, uncertainty in the Probabilistic framework must properly account for the variability which is part of nature and inherent in the phenomena under study, and uncertainty created in the analytical model, experimental data, correlations used etc. Even after considering these, there is a layer of uncertainty that I have not seen formally defined anywhere, but which common sense tells me plays an important role in most situations, viz. ambiguity in the decision-making, when trade-offs must be applied in an attempt to optimize between conflicting factors.

In the Probabilistic framework, the mapping of "cause" and "effect" may not be one-to-one. Any one cause may give rise to several effects, and any one effect may arise from several different causes. The relationship between a cause and an effect may be quite uncertain, and an analysis may express this uncertainty as a probability. The probability expresses the uncertainty. If the "cause" is a component failure and the "effect" of interest is adverse public health consequences, the "risk" is an expression of that uncertainty. Hence, there is no distinction between "risk" and "uncertainty".

Where a distinction is made between "risk" and "uncertainty", I believe that the characteristic being addressed is the spectral distribution of the risk parameter. For example, when DSI-12 states on page 19 "... lack of knowledge contributes to the uncertainty in estimated risks, ...", I gather the meaning that the distribution of the estimated risk is broadened by lack of knowledge. This conclusion, although quite consistent with common intuition, can be treated formally only through a Bayesian construction of the issues involved. Treating uncertainties in an other-than-Bayesian construct would be problematic, I believe. DSI-12 should be modified to reflect the alternative ways of viewing uncertainty.

How to collect information so that regulatory needs are met while licensees are not unduly burdened?

This is identified as the fifth subsumed issue under DSI-12. I believe that it is one of the more important issues the Commission faces even if there were no Paperwork Reduction Act or OMB regulations on information collection. On the regulatory side, the issue is one of avoiding decision-making paralysis. The paralysis occurs when no practical limit is set for the amount of information and analysis that a decision maker might require to support a decision.

Searching for ever more detailed information and increasingly fine tuned analyses addressing all eventualities are never-ending efforts. I believe that the key question to ask is whether ambiguity in the decision making process is likely to be reduced by incorporating more

information. There is a Probabilistic aspect to this question that must be addressed as part if risk-informed decision making. There are formal methods using techniques called "Value of Information" that may be applicable here. I am not aware of any attempts anywhere in NRC to apply such techniques.

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