March 22, 2002

Dr. George Apostolakis, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: PRESSURIZED THERMAL SHOCK TECHNICAL BASIS RE-EVALUATION PROJECT

Dear Dr. Apostolakis:

The staff appreciates the recommendations and comments that the Advisory Committee on Reactor Safeguards made in its letter of February 14, 2002, on the NRC's pressurized thermal shock (PTS) technical basis re-evaluation project. We appreciate your continued support for the PTS re-evaluation project and your advice on how it might be improved. In your letter you raised some specific questions and made some specific recommendations regarding the project to which the Staff would like to respond. Your questions and recommendations fell into the following two categories:

1. **Additional Information**:

   You are seeking additional information regarding the following topics:

   a. How dynamic events associated with a main steam line break will affect the assumed responses of the operators and the plant,
   b. How the Staff intends to address the variance narrowing associated with histogram sampling, and
   c. How the sensitivity of the results to changes in reactor operating power and fuel burnup rates will be addressed.

2. **Special Attention to Significant Factors that are Based Primarily on Judgment**:

   You have pointed out the need for the application of increased scrutiny and review of those factors that exert a large influence on the results, especially when the inputs associated with those factors are derived to a greater extent from expert opinions and judgments than they are from more conventional and quantifiable data sources. In specific you have called attention to the following two factors that fall into this category:

   a. Credit for operator action in response to events at the plant that can produce PTS challenges, and
   b. The spatial and size distribution of flaws that are assumed to exist within the reactor pressure vessel.

The Staff's responses to these questions, numbered in the same manner as above, are as follows:

1. **Additional Information**:

   a. Consideration of Dynamic Events in MSLB Scenarios: Using the "error forcing context" described in NUREG-1624 as part of its human reliability analysis, the staff did consider the entire context of a MSLB on the reactions of the crew. For example, we specifically considered the following distractions that might delay or prevent the crew's shutting off feed to the faulted steam generator:

      i. Major audible distractions (e.g., blowdown),
      ii. Dealing with possible subsequent nuisance alarms and equipment outages caused by the event (e.g., fire alarms going off),
      iii. Staff clamor outside the Control Room area related to their efforts to address the event, and
      iv. Dealing with personnel injuries caused by the event (such as if the break occurred in the turbine building while people were present).

      In its human reliability analysis, the staff considered these distractions, the procedures and training involved, and the time the crew has to perform the simple step of identifying the faulted steam generator and shutting off its feedwater (at least 10 minutes). The Staff concluded that there is a high probability of successful action by the operating crew. As such, the frequency of the undesired outcome is sufficiently low, even with consideration of related uncertainties, that it can be screened from the PRA.

   b. Variance Narrowing: In our current calculations we are assessing the degree to which our current calculational procedures may contribute to variance narrowing. If we find we have artificially underestimated the variance in the frequency results, we will use an alternative numerical technique that addresses this concern.

   c. Changes in Operating Power / Fuel Burnup Rates: The PTS re-evaluation project does not explicitly address reactor operating power or burnup levels, nor does it address the potential use of MOX fuels. The impact of operating power on PTS would largely be seen in neutron flux levels at the pressure vessel wall, and in turn, increased levels of embrittlement that can be predicted using the embrittlement correlations. In terms of burnup or MOX fuels, we expect that these effects would be seen as shifts in neutron energy spectrum, and potentially an increased flux level. The flux level would, again, be addressed through the embrittlement correlations. Past research has shown that, while energy spectrum can be important, the relatively modest changes in spectrum seen at the pressure vessel wall would not affect the embrittlement correlations used in this study. Thus, the Staff believes the effects of operating power level, burnup level, and MOX fuel are adequately addressed in the study.

2. **Special Attention to Significant Factors that are Based Primarily on Judgment**:

a. Credit for Operator Action: The existing credits for operator action have been established using a detailed consideration of the context associated with each scenario and its' related human events. This was done using ATHEANA guidelines, by performing a detailed review of the context of each scenario and accounting for reasonable variations, using NRC Staff and NRC contractor experts to arrive at mean estimates and uncertainties for these probabilities. Probability estimates and justifications arrived at by this process were independently reviewed by Oconee personnel and revisions were made where deemed warranted by the NRC contractors. Certainly the ACRS' comment is well taken that the magnitude by which these credits (which are based largely on expert judgment) reduce PTS risk relative to more quantitative/quantifiable factors should be assessed to better place into perspective the relative importance of expert judgment to the overall result. This assessment (of the magnitude of risk reduction attributable to individual parameters/models) is being conducted as part of the on-going PTS re-evaluation project. Additionally, we feel that having results from more than one plant will be key in assessing the importance of operator action credit relative to other features of the analysis.

b. Flaw Distribution: A subsequent conversation between a Staff member and Dr. William Shack of the ACRS clarified that the ACRS had been left with the impression that the flaw distribution inputs rely to a considerable extent on expert judgments. However, this is not the case. The flaw distribution used in the PTS re-evaluation is based primarily on experimental data obtained from destructive and non-destructive evaluation of RPV plates and weldments. Certainly, information that the Staff gained from the expert judgments has been incorporated into the flaw distribution, but the actual degree of this influence is small. To help address this misunderstanding regarding the technical basis of the flaw distribution, the Staff and its contractors are currently preparing a report which will discuss in detail the basis for the flaw distribution. We look forward to the opportunity to discuss this report with the ACRS at a future date.

We look forward to continued interactions with the Committee to periodically discuss the progress made in completing the PTS re-evaluation project.

Sincerely,

/RA/

William D. Travers
Executive Director
for Operations

cc: Chairman Meserve
Commissioner Dicus
Commissioner Diaz
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