PDR

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Dr. Roy H. W. Woods
Generic Issues Branch
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Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Phillips Building, Mail Stop 268
Washington, D.C. 20555

Dear Dr. Woods:

The following brief conclusions and recommendations by the PNL team on PTS are based on the draft NRC staff report on PTS dated September 13, 1982. We expect to revise our draft Supplement 1 to NUREG/CR-2837 to substantiate these findings.

1) The 270°F generic screening criterion for longitudinal welds is acceptable. This conclusion is largely based on the following factors:

   a. The plant specific assigned RT_{NDT} will be selected as described in Section 5 of the NRC staff report. This conservatism provides approximately 60°F to the mean RT_{NDT} used in constructing the staff's PRA results. It should be understood that the material properties conservatisms include mostly known uncertainties that reflect true variability in actual properties of vessels. Less than one-forth of the total conservatism can be attributed to measurement procedures unique to pressure vessel embrittlement that do not reflect variability in actual vessels. This added conservatism is likely more than compensated by unquantified uncertainties associated with added uncertainties of (1) key plant welds having extreme characteristics (high Cu, high Ni and high fluence), (2) extrapolation of surveillance characteristics to the vessel wall and (3) the correlation of charpy V-notch values to fracture toughness values.

   b. Using the more conservative methods described under 1.a., the probability of crack extension without arrest would have a frequency probability per reactor year of approximately 10^{-6} using the NRC staff PRA results, Figure 8-3.

   c. Currently the NRC staff PRA and operating history data analysis does not separately address each reactor type (W, B&W, CE). Therefore, the magnitude of conservatism inherent in the screening criterion is not consistent among plant types. The requirement for plant specific analysis to be started within three years of reaching the screening criteria should compensate for any specific unconservatism.

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2) The predicted uncertainty of the PRA results reported as plus or minus two orders of magnitude could result in a frequency of failure of 10^{-4}. This range is apparently consistent with the safety goal[1] for core melt and significant release events. However, the vessel integrity prediction of less than 1×10^{-6} could be seriously compromised by PTS events. The plant specific PTS evaluations should be required to demonstrate a predicted vessel failure frequency probability of no greater than 10^{-6}[2], methods for satisfying the NRC safety goals, or an effective increase in the plant RT_c of 50°F by corrective actions before any adjustment is made to the plant specific limiting RT_{NDT}. The 50°F is approximately equivalent to two orders of magnitude on the NRC staff PRA curve, Figure 8-3.

Factors which support this conservative approach include:

Uncertainty and probability appear throughout the evaluation of pressurized thermal shock. These topics have been handled through a combination of statistical methods and conservative judgment. Overall, uncertainty has been handled about as well as available techniques, knowledge, and data permit. Even so, there are still enough imponderables so that identified conservatisms should be relaxed only with due caution. Some reasons for this caution are given below.

Operating History

Useful interpretation of the accumulated operating experience of PWRs is hampered by the facts that relatively few PTS events have occurred, and these events are not well characterized. To some extent one can avoid these difficulties by considering "distribution of exceedances"[3]; that is, events that are more severe than any that have occurred to date. If we assume that the history of 350 operating years is relevant to the present 47 plants, then there is a probability of 0.118 that one of the plants will have a severe PTS event in its next operating year. Further, the basic data suggests that there is approximately a 2% chance that 1 of the 8 sensitive plants will experience a severe PTS event in its next operating year.

PRA

The techniques used in PRA provide the most sophisticated and reliable method available for assessing risk in the face of uncertainty. Unfortunately, experience suggests that failures of a complex system are frequently due to a combination of circumstances that were not, or would not have been, discovered using PRA. Also, such failures are often of the "common mode" or dependent type of failures where the occurrence of a single unfound event engenders the occurrence of several "unlikely" events which culminate in system failure. One such example is the Rancho Seco PTS event; another is the Brown's Ferry fire.

Uncertainty on RT_{NDT}

The use of a "2σ" uncertainty term for RT_{NDT} probably does not provide as high a level of confidence as was intended by the staff. An interval of the "mean $\pm 2\sigma$" covers 95% of a population if (1) the population has a normal distribution

and (2) the mean and standard deviation are known exactly, not estimated from data. Neither of these conditions are satisfied in the present case.

VISA Analysis

The primary shortfall of the VISA code, and indeed, our present state of knowledge, is the lack of a definitive stochastic structure for the system simulated by VISA. The present structure is the default that arises from assuming that all errors or uncertainties are independent. The effect of this assumption is to make unfavorable combinations appear infrequently in the simulation. However, if an unfavorable value of some variable tends to result more frequently when some other variable is at an unfavorable value, then the estimated probabilities may be much too low.

Material Properties

Uncertainties should be applied uniformly to all forms of metal and irradiation conditions. Hence, the Reg. Guide 1.99 upper bound should not be used to replace the statistical trend curves for the high Cu, high Ni and high fluence welds. Also, an appropriate standard deviation for the initial RT_{NDT} of plate and forging metals should be used as for welds.

References

1. NUREG-0880 (for comment), Safety Goals for Nuclear Power Plants: A Discussion Paper, February 1982.

2. Report on the Integrity of Reactor Vessels for Light-Water Power Reactors, The Advisory Committee on Reactor Safeguards, January 1974.

3. Letter, Donald L. Stevens, Jr., to Dr. Roy H. M. Woods, dated June 22, 1982.

Yours truly,

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LTP:mkw

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