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Advisory Committee on Reactor Safeguards
Washington, D. C. 20555

Dear Dr. Shewman:

As you requested, I am following up my participation in the meeting of May 23-24, 1985, with comments on the portions of the presentations which dealt with use of fracture mechanics to justify the leak-before-break approach to piping. I have also studied the relevant portion (Appendix A) of Volume 3 of NUREG-1061. I will also respond to your letter to me of April 28, 1985.

As a general remark, I would like to say that the approach spelled out in Appendix A of Volume 3 represents a sensible implementation of developments in elastic/plastic fracture mechanics which have occurred over the last ten years or so. Although aspects of the implementation are in need of further refinement, as the report makes clear, the approach itself is firmly grounded. The implementation in Appendix A is well tied to experiments. Where uncertainties do exist, conservative options have been favored.

At the meeting of May 23, 1985, it was emphasized that the data base for the tearing resistance curve behavior of the piping and weld materials needs enlargement. I would also urge the NRC to continue to try to improve the analytical procedures for estimating the relation between the driving force J and the applied moment. Figure A-9 of Appendix A illustrates that the three estimation schemes considered are very far apart. I'm not questioning that the report did settle upon a conservative estimation procedure for determining crack advance and stability. But I do feel the wide discrepancies among the estimation schemes should be resolved. I was involved in the early development of the EPRI estimation scheme and so I am most familiar with it. I'm somewhat surprised that the discrepancy in Fig. A-9 is as large as a factor of 2 at the low end of the moment range ($\approx$800 in-kips) where yielding should still be fairly limited and the elastic predictions should be reasonably accurate. In any case, I believe the analysis can be carried out much more accurately than the spread in the estimation schemes would suggest, and this should be addressed as part of the ongoing research activity to complement an enlarged material data base.

In your letter of April 28, 1985, you raise the question of the ductility needed to give fully plastic crack behavior, particularly where Charpy energy levels have been degraded. If I understand your question correctly, I think the J-tearing resistance test itself ensures that there is enough ductility available for fully plastic crack growth, assuming the test specimen has comparable thickness to the cracked component in the application, and assuming a dynamic cleavage crack is not made to run by a dynamic loading event. (If a component

experienced a prestrain prior to cracking which degraded the toughness of the material, then of course one should use J-resistance curve data taken from material which had also received the same overall prestrain. But I doubt that this is a major issue.)

It seems to me that a degradation in Charpy energy, with relatively little accompanying change in ductility or resistance curve behavior, reflects a susceptibility of the material to cleavage (or quasi-cleavage) at the higher strain rates associated with the Charpy test. The J-resistance data is taken at relatively low strain-rates compared to a Charpy test and presumably involves little or no cleavage. Under these conditions it seems to me that one must be certain that no dynamic loading events could lead to dynamic unstable crack growth by the brittle cleavage mode if piping is to be considered safe based on the approach that has been proposed.

I hope these comments are helpful. Please feel free to write or call if I can be of further assistance.

Yours sincerely,

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