September 5, 2008

Comments on RIL 0801 and NUREG/CR-6967

Dear Michael Lesar,

Thank you for the opportunity to comment on the Research Information Letter 0801 and NUREG/CR-6967. On behalf of the Fuel Safety Research Group of Japan Atomic Energy Agency, I would like to make general and technical comments in the following.

General comments

A zero-ductility criterion combined with ring-compression testing is used in the research reported in the NUREG/CR. The test methodology is basically the same as that used more than 30 years ago by Hobson and Rittenhouse. The current US criteria are also based on that methodology. However, the loading of the fuel rods and fuel behavior in a LOCA was not well known at that time and it was thus considered that a zero-ductility limit (saying basically that the cladding should maintain some ductility) would be suitable for avoiding extensive degradation of fuel bundle and loss of coolable geometry of the reactor core. As stated in the NUREG/CR, the same methodology is adopted to determine burnup and alloy effects.

As said above, the zero-ductility approach was adopted three decades ago because fuel behavior and loading conditions under LOCA conditions were not well investigated at that time. However, fuel behavior has since then been the subject of extensive investigations and calculation tools have been considerably refined. Because of this progress, loading conditions during and after a LOCA can be calculated today. For the revision of the regulation, we believe it useful that you have a discussion about more modern methodology applicable for the purpose of confirming coolability of the reactor.

The ANL testing method is possibly too severe and non-realistic for judging cladding embrittlement and loss of integrity under LOCA conditions, and the zero-ductlity approach may prove to be unnecessarily conservative. Further, there are several details of the experimental method and way to infer zero-ductility that can be disputable. Regarding applicability, a point of controversy may be on whether the criterion should apply to the ballooned region or not, since this is the weak point of the cladding. If we neglect the ballooning region and concentrate on zones away from the ballooning – which must be justified – the question would be on the appropriateness of two-side oxidation, since steam availability at the rod interior is likely to be very limited if any, when we move away from the burst. Deformation is localized and strain is concentrated at inner or at surfaces of four circumferential positions in the ring compression test. Under such conditions, it is questionable to draw embrittlement threshold with four data points obtained with two fuel types.

Additional technical comments

- (Figure in Executive summary of NUREG/CR) What do the data points mean?
- Is corrosion during service included in the calculated ECR for the irradiated cladding? Or is the ECR calculated for the thickness of the metallic part?
- (Figure 48 in NUREG) Does the ductility of cladding measured by the ring compression test depend on the cladding thickness?

Sincerely,

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