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POWER SYSTEMS

November 16, 1979
LD-79-067

Mr. Darrell G. Eisenhut
Assistant Director f- Systems and Projects
Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Fuel Cladding Swelling and Rupture Models

Reference: Letter LD-79-064, A. E. Scherer to D. G. Eisenhut, dated November 2, 1979

Dear Mr. Eisenhut:

The referenced letter provided Combustion Engineering's (C-E) response to several NRC concerns regarding rupture strain and flow blockage. Subsequent to receipt of the letter, additional questions arose concerning the impact of heating rate dependent burst temperature effects on rupture time and rupture strain/blockage and ultimately on peak cladding temperature (PCT) in the analysis of a large break LOCA. The following evaluation of the potential impact of heating rate dependent burst temperature on C-E's licensing calculations is provided in support of our operating plant customers.

The C-E rupture temperature model does not have heating rate dependence. For the heating rate range of C-E operating plants, 2-10^{o}C/sec and using the ORNL model recommended by the Staff, heating rate effects would lower predicted rupture temperatures by 25-75^{o}C. The resulting lower rupture temperatures due to low heat rate effects produce earlier rupture times, (2-20 seconds earlier).

If rupture occurs after the time of <1 in/sec reflood, degraded heat transfer on the rupture node and above (as required by Appendix K) is invoked at the time of rupture. Earlier rupture times could lead to higher reflood PCT in this case because of the earlier implementation of degraded heat transfer. However, all C-E operating plants experience clad rupture prior to the time of <1 in/sec reflood and therefore the initiation of degraded heat transfer would not be affected by lower rupture temperatures. Earlier rupture times during the blowdown or refill periods may alter local heat transfer momentarily, through gap conductance or radiation enclosure effects. However, if the PCT occurs during late reflood its impact on PCT would not be significant.

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Lower rupture temperatures due to low heat rate effects may produce higher rupture strains and blockages. The effect of increased rupture strain and blockage was addressed in the referenced letter to the Staff. The results of the previously discussed System 80 sensitivity studies show that PCT calculated with the revised flow blockage/heat transfer model is slightly lower than PCT calculated with the present flow blockage/heat transfer model. In addition, the results of a study show that increasing the degree of flow blockage from 60% to 80% only increases the PCT by 40°F. Based on these results, we conclude that all C-E operating plants continue to comply with the 2200°F peak cladding temperature criterion, including the effects of increased rupture strain/blockage.

The above discussions indicate that the reported PCT for all C-E operating plants would not be significantly affected by a heating rate dependent rupture temperature model. The magnitude of the effect on PCT would be no greater than effects observed in the System 80 sensitivity studies using the C-E alternate models. In fact, it is expected that using revised flow blockage/heat transfer models with or without a heating rate dependent burst temperature model for the analysis of C-E operating plants would produce lower PCT than presently reported values. C-E therefore believes that our Evaluation Model analysis with the revised flow blockage/heat transfer model meets Appendix K requirements and the 2200°F peak cladding temperature criterion.

If I can be of any further assistance on this matter, please contact me or Ms. J. M. Cicerchia of my staff at (203)688-1911, Extension 2595.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Licensing Manager

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