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SUBJECT: Forwards supplemental info to 851230 proposed change to Tech Specs on moderator temp coefficient.

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Office of Nuclear Reactor Regulation
Attention: Mr. Ashok C. Thadani, Director
PWR Project Directorate #8
Division of PWR Licensing - B
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Thadani:

Re: St. Lucie Unit 2
Docket No. 50-389
Moderator Temperature Coefficent

By letter L-85-474 (December 30, 1985), Florida Power & Light Company submitted a proposed change to the St. Lucie Unit 2 Technical Specifications on moderator temperature coefficient. The attached information is being submitted to supplement our proposal and to assist your staff in completing their review.

Very truly yours,

C. O. Woody
Group Vice President
Nuclear Energy

COW/MAS/gp

Attachment

cc: Dr. J. Nelson Grace, USNRC, Region II
Harold Reis, Esquire, Newman & Holtzinger

A001

MAS2/011/1

NRC Question

Why didn't the reactivity versus moderator density curve used in the Cycle 2 LOCA analyses change when the Technical Specification on MTC was made more positive?

Response

One input to the LOCA analysis is a curve of the change in reactivity as a function of the change in moderator density. In general, this curve depends on the MTC assumed. The curve is associated with one component of the MTC; namely, moderator density. Only this component is significant, since for a LOCA the depressurization of the primary system results in appreciable moderator density changes but with little or no change in moderator temperature. This LOCA input curve is one that has been normalized to zero reactivity change at the nominal hot full power (HFP) moderator density. The calculational model is adjusted to force the MTC to be equal to the most positive HFP MTC permitted by the Technical Specifications. This is necessary because the calculated BOC MTC, at the nominal conditions, is always less positive than the Technical Specification limit. The adjustment made is to set the dissolved boron concentration artificially high. This forces the MTC predicted by the model to be equal to the limiting Technical Specification value.

A description of how the moderator temperature and moderator density components of the MTC vary from cycle to cycle, and how just the moderator density dependent component has been treated in the St. Lucie 2 LOCA analyses, is provided in Sections A and B, below.

Section A

The moderator temperature coefficient (MTC) can be defined as follows:

$$MTC = MTC_d + MTC_t$$

where MTC = the reactivity change per unit change in moderator temperature. This includes the change in reactivity due to changes in both moderator temperature and moderator density.

MTC_d = the reactivity change per unit change in moderator density (in units of equivalent moderator temperature change). To evaluate this quantity, the calculation is run at a constant moderator temperature, but with moderator density varied.

MTC_t = the reactivity change per unit change in moderator temperature. To evaluate this quantity, the calculation is run at a constant moderator density, but with moderator temperature varied.

Solving the above equation for MTC_d gives:

$$MTC_d = MTC - MTC_t$$

At the beginning of first cycles, the MTC_t is negative. Therefore, as the equation above shows, the MTC_d is more positive than the MTC. For reload cycles, the MTC_t becomes positive due to the increased neutron absorption in plutonium, which has been built up during fuel depletion. Consequently, the MTC_d, for reload cycles, is less positive than the MTC. Therefore, the reactivity versus moderator density curve for a first cycle is more limiting than that for a reload cycle as long as the MTC limit doesn't change.

Section B

Two Large and Small Break LOCA analyses have been performed for St. Lucie 2, Cycle 2. The first LOCA analysis, supporting the initial startup of Cycle 2, assumed a $+0.2 \times 10^{-4}$ $\Delta\rho/°F$ HFP MTC. The second LOCA analysis, which is presently under review, supported an increase in the MTC limit from $+0.2 \times 10^{-4}$ $\Delta\rho/°F$ to $+0.3 \times 10^{-4}$ $\Delta\rho/°F$. A description of how the reactivity versus moderator density curve for these LOCA analyses was calculated follows:

1. First LOCA Analyses

   For Cycle 1, the Large Break LOCA was analyzed assuming a reactivity versus moderator density curve based on a $+0.5 \times 10^{-4}$ $\Delta\rho/°F$ MTC while the Small Break LOCA analysis was based on a reactivity versus moderator density curve for a $+0.2 \times 10^{-4}$ $\Delta\rho/°F$ MTC. For the first set of Cycle 2 Large and Small Break LOCA evaluations, the Cycle 1 reactivity versus moderator density curve based on a $+0.2 \times 10^{-4}$ $\Delta\rho/°F$ MTC was assumed. As discussed in Section A above, the Cycle 1 curve is limiting for Cycle 2.

2. Second LOCA Analyses

   For the second set of Cycle 2 LOCA analyses, associated with justifying an increase in the MTC limit from $+0.2 \times 10^{-4}$ $\Delta\rho/°F$ to $+0.3 \times 10^{-4}$ $\Delta\rho/°F$, the MTC_d had to be re-evaluated. It was expected that, even with a more positive MTC, the reactivity versus moderator density curve from Cycle 1 assumed for the original Cycle 2 LOCA analyses would still be bounding. To prove this, the Cycle 2 reactivity versus moderator density curve was conservatively approximated by calculating a reactivity versus a moderator temperature and density curve (i.e., a curve containing both components of the MTC). The calculated curve was shown to be still bounded by the Cycle 1 curve. Therefore, the Cycle 1 curve was used in the LOCA analyses covering the more positive MTC limit.

NRC Questions

a) Why is the initial steam generator pressure in the new analysis of the Feedwater Line Break (FLB) event higher than that in the reference FLB analysis for Cycle 2, considering the fact that 1500 tubes in each steam generator are now assumed to be plugged?

b) Where does the 815 psia design value for steam generator pressure come from?

c) What is meant by "peak Reactor Coolant System (RCS) pressure includes extra 10 psia for conservatism?"

Response

a) When the original licensing calculation of the FLB event was performed for Cycle 2, the initial steam generator pressure was intentionally set to a low value (i.e., 809 psia) to ensure that the main steam safety valves would not be predicted to open prior to the time of peak RCS pressure. This was done knowing the following: (1) The peak RCS pressure would not approach the analysis limit (i.e., the 2750 psia upset limit), and (2) changing the initial secondary pressure has a second order effect on the analysis results (i.e., during the reanalysis for Cycle 2 it was determined that an 84 psia increase in initial secondary pressure only caused a 13 psia (or ~1/2 %) increase in the resulting peak RCS pressure). Therefore choosing a low initial pressure was simply a convenient way to assure that the secondary valves wouldn't open.

For the new cycle FLB event analysis it was suspected that a more positive MTC would cause the resultant peak RCS pressure to increase and that a significant amount of steam generator tube plugging in combination with a more positive MTC might cause the limiting break size to change. This led to the suspicion that the RCS pressure would end up being much closer to the analysis limit of 2750 psia than the original Cycle 2 FLB analysis showed. In order to determine the combined effects of the steam generator tube plugging and more positive MTC, a parametric FLB study was performed. To ensure that the results of this parametric study were bounding, the assumed initial steam generator pressure was also varied. The new parametric FLB event analyses showed that a higher initial steam generator pressure (893 psia) produced the highest calculated peak RCS pressure. This was the case because, even with the higher initial secondary pressure, the secondary safety valves did not open until after the peak RCS pressure were achieved. This analysis also showed that a higher initial secondary pressure reduces slightly the amount of primary-to-secondary heat transfer. With less secondary cooling, the RCS heat-up is slightly more severe and leads to a slightly higher peak RCS pressure.

The 893 psia initial steam generator pressure was reported in the revised FLB event licensing write-up because it is conservative and leads to a bounding analysis as intended. This was done even though, steady-state analyses, using C-E's code CESEC, showed that the initial steady-state steam generator pressure decreases as a result of plugging 1500 tubes in each steam generator. Specifically, the full power design secondary pressure, was found to be about 35 psia lower than the comparable case with only 200 tubes per steam generator assumed to be plugged.

b) The 815 psia "design" value is the lower pressure end of the design range for the steam generators. It comes from Section 5.4.2.1 of the Final Safety Analysis Report for St. Lucie Unit 2.

c) The 10 psia added to the calculated peak RCS pressure for the new Cycle 2 FLB analysis represents an added buffer to ensure that any unanticipated small changes to the FLB event analysis input in future reload cycles would not necessitate a change in the quoted peak RCS pressure for this event.