Florida Power
CORPORATION

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Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72
Nuclear Instrumentation (NI) Induced Error Transients

Dear Mr. Eisenhut:

Mr. Robert Reid's letter, dated January 14, 1981, to all operating Babcock and Wilcox reactor licensees concerning NI induced error transients requested that Florida Power Corporation provide justification for continued full power operation of Crystal River Unit 3. Florida Power Corporation had evaluated this concern and secured the services of Babcock and Wilcox to conduct a study.

One concern identified in Mr. Reid's letter was that postulated overcooling events could result in the actual reactor power level exceeding 112% full power before a reactor trip as assumed in the safety analysis in the FSAR. The evaluation by Babcock & Wilcox has shown that the increase in reactor power is offset by the beneficial effect of the temperature decrease on core thermal margins. Departure from Nucleate Boiling Ratio (DNBR) analyses performed for the most limiting condition (of indicated power at high flux trip limit of 105.5%, reactor coolant pressure at the low pressure trip limit of 1800 psig) demonstrate that the minimum DNBR will be greater than 1.30 for conditions under which a reactor trip would be initiated at reactor power levels up to 150% of rated power. In addition, Cycle 3 calculated core power distributions at all allowable rod index and Axial Power Shaping Rod (APSR) positions for normal full power operation were examined and margin existed for both Departure from Nucleate Boiling (DNB) and Centerline Fuel Melt (CFM) assuming an actual core power of 123%. It is therefore concluded that the induced flux measurement error does not compromise the safe operation of Crystal River Unit 3 during overcooling events initiated from anywhere within the allowable operating range.

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The concern on the rod ejection transient is that the high flux trip may not be activated for an ejected rod with a reactivity worth less than 0.2% $\Delta k/k$. Under these conditions, current models would show unacceptable results (peak fuel enthalpy > 280 calories/gram). Although no reanalysis has been performed, an engineering evaluation of the conservatisms in the original analysis, such as adiabatic heatup, has led to the conclusion that a reanalysis using realistic assumptions will show that the peak fuel enthalpy will not exceed 280 calories/gram. Therefore, this concern is not considered to compromise the safe operation of Crystal River Unit 3, Cycle 3.

The specific response to the concerns stated in Mr. Reid's letter are attached. If you require any further discussion concerning our response, please contact this office.

Sincerely,

FLORIDA POWER CORPORATION

Patsy Y. Baynard

Patsy Y. Baynard
Manager
Nuclear Support Services Department

Attachment

Klein(W06)DN51-2

ATTACHMENT

Concern

1. Determine if the high flux trip setpoint for your plant is affected by the accident-induced neutron flux errors discussed above. Provide us with information establishing that your present accident and transient analyses are valid and that the present Technical Specification limits provide as a minimum the original protective margin derived from the safety analyses; if not, provide the following information:

   a. Confirm that only the two non-205 FA plant concerns discussed in the B&W letter of October 29 affect your plant; namely, small overcooling events including a small steam line break, and a rod ejection accident.

Answer

Babcock and Wilcox's safety analysis study for a 205 fuel assembly plant indicated that there were three possible accident types that could induce a neutron transient error greater than the 2% full power transient error assumed in the safety analysis contained in the Final Safety Analysis Report. The three accident types were:

(1) Small overcooling and small steam line break.
(2) Large steam line break in containment.
(3) Rod ejection accident.

Crystal River Unit 3's Reactor Protection System has a High Reactor Building Pressure Trip that adequately protects against the large steam line break accident. Therefore, the only two concerns for Crystal River Unit 3 are the small overcooling events including a small steam line break and a rod ejection accident.

Concern

1.b. Provide the effects of the error on your plant, supported by appropriate analyses.

Answer

Although no transient analysis has been performed specifically for Crystal River Unit 3, an engineering evaluation analysis has shown that the maximum transient induced error for moderate frequency overcooling transients will be approximately 13%. Therefore, for

moderate frequency overcooling transients only, the instrumentation error that should be considered is:

0.8%	Heat Balance (The NI's are recalibrated whenever their indicated power is less than 0.8% of the heat balance).
2.0%	Steady State Neutron Measurement.
0 to 13%	Transient Neutron Measurement Dependent on Coolant Temperatures.
0.5%	Instrumentation Error.
16.3%	Total.

To justify full power operation, one must demonstrate that operation up to 122% full power is acceptable during these overcooling transients. This power level is based on a high flux trip setpoint of 105.5% full power plus a total error of 16.3%. It should be remembered that 122% full power can only be reached during certain overcooling transients that provided specific core conditions.

The analysis of induced flux errors during overcooling transients had led to the quantification of the ratios of indicated power to actual reactor power as a function of downcomer fluid temperature and reactor average coolant temperature. The primary concern is to determine the conditions that would permit the actual reactor power to exceed 112% without a reactor trip occurring. The error calculations were used to determine the maximum actual reactor power as a function of temperature for the case where the indicated power would be 105.5% which is the high flux trip setpoint. A series of heat balance calculations have been performed, using the minimum licensed RCS flowrate (374,880 GPM), to determine the corresponding reactor core operating conditions.

In order to quantify reactor core thermal margin for the conditions corresponding to operation at an indicated power level of 105.5%, DNBR calculations were performed. All 2200 psia Reactor Coolant System pressure points allowed by the Reactor Protection System and corresponding to operation with indicated power equal to 105.5% lie well above the Technical Specification minimum DNBR of 1.30 for the B&W-2 correlation(1). For low pressures corresponding to the RPS low pressure setpoint (1800 psig), the variable low pressure trip provides protection to a minimum DNBR of 1.3 for reactor power levels up to 121% full power. In addition, the high flux trip provides protection to the minimum DNBR of 1.3 above 120% full power.

(1) B&W -2 correlation is documented in "Correlation of Critical Heat Flux in Bundle Cooled by Pressurized Water," BAW-10000A, Babcock and Wilcox, Lynchburg, Virginia, May 1976.

Three dimensional power distribution calculations were performed to assess the reactor power distribution perturbation at 123% full power due to an overcooling transient, and to determine the margins to centerline fuel melt and DNB limits. Identical calculations were generated from normal steady-state operation at 100% full power and from operation at 123% full power with a 16°F inlet temperature reduction. All power distribution calculations were initiated from within or near the normal rod index, APSR and axial imbalance limits of operation, such that the core behavior over the entire allowable operating range was examined. In addition, these calculations accommodate a proposed power level upgrade for Crystal River Unit 3 from 2452 to 2544 MWt.

Centerline fuel melt and DNB margins were computed for the 123% full power cases to determine if core safety limits would be preserved during an overcooling transient. Since all calculations were performed from near steady-state condition, appropriate peaking factors were included in the 123% full power margins calculations to account for potential peaking increases due to transient xenon and quadrant tilt. Maximum allowable peaking curves for CR-3, Cycle 3, were used to evaluate the DNB margins. The applicability of these curves at 123% full power was verified by DNBR analyses performed for the limiting cases.

The increased power level resulting from certain overcooling transients can be accommodated with the present Cycle 3 operating limits while allowing the upgraded power level of 2544 MWt. The analysis of the most limiting peaking distribution yielded DNB margins in excess of that required to offset the 2.8% rod bow DNB penalty for this cycle. The high flux trip provides DNBR protection to the minimum DNB limit.

The concern on the rod ejection transient is that the high flux trip may not be activated for an ejected rod with a reactivity worth less than 0.2% k/k. Under these conditions, current models would show unacceptable results (peak fuel enthalpy > 280 calories/gram). Although no reanalysis has been performed, an engineering evaluation of the conservatisms in the original analysis, such as adiabatic heatup, has led to the conclusion that a reanalysis using realistic assumptions, will show that the peak fuel enthalpy will not exceed 280 calories/gram. Therefore, this concern is not considered to compromise the safe operation of Crystal River Unit 3, Cycle 3.

Concern

1.c. Provide your program and schedule for mitigating the effects of the error.

Answer

The analysis performed to answer Question 1.b shows that the reactor core is adequately protected at present and no additional analyses or equipment is required to mitigate the effects of the neutron flux induced errors identified in Question 1.a.

Concern

2. Provide justification for continued full power operation of your plant until your program to mitigate effects of the error is completed.

Answer

The analysis done for Question 1.b shows that Crystal River Unit 3 can accommodate a power level upgrade from 2452 to 2544 MWt at its present design configuration and its present Reactor Protection System. No program to mitigate the effects of the induced neutron transient error is required.