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October 22, 1985

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Director of Nuclear Reactor Regulation
ATTN: Mr. Edward J. Butcher, Acting Chief
Operating Reactors Branch #3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
CPC System Response to CEA Inward Deviation
Additional Information

Gentlemen:

In response to the ANO-2 NRR Project Manager's request, the attached information is provided to address your staff's questions pertaining to the ANO-2 Technical Specification change request of August 30, 1985 (2CANØ885Ø1). This information was discussed with Mr. Y. Hsii and the NRR Project Manager in a telephone conversation with my staff and representatives of Combustion Engineering on October 15, 1985.

Very truly yours,

Dale E. James for J. Ted Enos

J. Ted Enos
Manager, Licensing

JTE/DEJ/sg

Attachment

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Question 1:

The proposed Technical Specification changes are intended for the removal of the CPC inward CEA deviation penalty (penalty factors reduced to 1.0) by (a) taking credit of the COLSS required over power margin and (b) requiring a power reduction 15 minutes after a CEA misalignment. Provide the analysis specific to ANO-2 to show that the thermal margin maintained using the COLSS operating limit is sufficient to accommodate the CPC penalty (i.e., the static penalty component) needed immediately after a CEA deviation.

Response:

The COLSS is used to monitor the DNB limiting conditions for operation. The system preserves sufficient margin in terms of core flow (i.e., biasing the steady state flow by a multiplier) and the Power Operating Limit (POL) bias to the DNB SAFDL so that DNB would not occur during normal operation or any AOO. The COLSS POL bias term automatically sets aside thermal margin in the COLSS system. It is implemented as a function of core power level. The combined margin is equivalent to a penalty multiplier on core power of 1.1756 at full power, and more at lower powers. The margin is referred to as the Required Overpower Margin (ROPM) for ANO-2.

The radial distortion factor is defined as the ratio of the radial peaking factor (RPF) after a CEA drop to the RPF before the CEA drop. The maximum radial distortion factor at 90% power for the single full length CEA drop event is 1.095.

The maximum derivative of ROPM with respect to the radial distortion factor has been determined by an extensive sensitivity study to be 1.08. The ROPM required for the single CEA drop is therefore:

$$\text{ROPM} = (1.095 - 1.0) * 1.08 + 1.0 = 1.103$$

The required ROPM is thereby shown to be less than the minimum COLSS ROPM.

Question 2:

The proposed Figure 3.1-1A requires a power reduction 15 minutes after a CEA misalignment to compensate for the needed CPC CEA deviation penalty due to the dynamic xenon effect. Provide the analysis specific to ANO-2 to show that the power reduction as specified is enough to compensate for the worst penalty factor that can occur for any CEA deviation from any initial configuration to ensure that the worst deviation will not cause a violation of the specified acceptable fuel design limits.

Response:

The thermal margin maintained using the COLSS ROPM and power dependent operating limit is sufficient to accommodate the CPC penalty (i.e., the static penalty component) needed immediately after a CEA deviation and a Xenon redistribution penalty for up to 15 minutes after a deviation.

Between 15 minutes and 1 hour after a deviation, the increasing redistribution penalty is proposed to be accommodated by a power reduction required by Figure 3.1-1A.

The worst redistribution penalty that can occur for any CEA deviation from any initial configuration is modeled as linear with time. The maximum value for ANO-2, cycle 5 is 1.155 at 1 hour. The distortion factor for 15 minutes of Xenon is $[(1.155-1)/4] + 1 = 1.039$. The combined distortion factor is 1.138 ($1.039 * 1.095$) which implies a power penalty of 1.150, less than the COLSS ROPM. Because the combined distortion factor at one hour ($1.095 * 1.155 = 1.265$) implies a power penalty greater than the COLSS ROPM, an additional penalty is required and is effectively provided via the power reduction of Figure 3.1-1A. Because the static penalty component is assumed to remain constant, the combined penalty varies by the ratio of the dynamic penalty component, or $1.155/1.039 = 1.112$ between 15 minutes and 1 hour. This additional combined penalty multiplier of 1.112 implies a power penalty divider of:

$$(1.112 - 1.0) * 1.08 + 1.0 = 1.121.$$

Thus the POL must be reduced by a factor of 1.121. The required 20% power reduction conservatively implements this penalty.

Question 3:

Since the COLSS required overpower margin are credited for compensation of the CPC CEA deviation penalties, this power operating limit margin is not available and must be compensated for when the COLSS is out of service. In San Onofre, this is done by restricting the full length CEA to the Short Term Steady State Insertion Limit (STSSIL) when the COLSS is out of service. The ANO-2 Technical Specification 3.1.3.6 does not require any additional restriction on the CEA insertion limit when COLSS is out of service. How do you compensate for the deviation penalty when the COLSS is out of service? Provide your analysis.

Response:

During operation with the COLSS out of service, the CPCs are used to monitor plant operation using a limit that includes only the margin for the loss of flow event. The POL bias component is not included. The inclusion of the POL bias in the CPC operating limit would unnecessarily complicate the procedure. Thus, the entire margin requirement has to be accommodated in the CPC operating limit.

For ANO-2, the current Power Dependent Insertion Limit (PDIL) was retained. In order to maintain the required POL bias during the first 15 minutes after a single CEA drop, the DNBR limit line for COLSS out of service (TS Figure 3.2-4) was increased by 0.1. A different approach was used for San Onofre: the COLSS out of service CPC operating limit was optimized by restricting the PDIL when COLSS is out of service.

Question 4:

With the part-length CEA's restricted to the insertion limit shown in Figure 3.1-3, what will be the maximum positive reactivity insertion with a PLR drop. What is the minimum ROPM for COLSS? Describe how this ROPM is sufficient to accommodate the power increase resulting from a PLR drop.

Response:

The part length insertion limits of the referenced figure prevent a positive reactivity insertion for a single PLR drop at all power levels above 50% of rated power. Single PLR drops from allowed positions below 50% power could have a positive reactivity insertion starting from an initial worst case negative ASI within the LCO space.

For PLR drops from power levels above 50% power the minimum 1.1756 ROPM set aside for the 4 pump loss of flow accident (see response #1) is more than adequate to accommodate the power redistribution due to a PLR drop because there is no power increase and because PLR drop distortion is less than that of single full length drops.

For PLR drops from power levels below 50% power, the minimum 1.1756 ROPM is augmented by margin available due to the low initial power. The minimum power at which a POL can be reached in the LCO space has been demonstrated to be at least 85.0% of rated power. Thus the actual ROPM available to accommodate a PLR drop from below 50% power is at least:

$$(1.1756)(85.0\%\ \text{power})/(50\%\ \text{power}) = 1.99.$$

This is sufficient to accommodate the power increase from a PLR drop with positive reactivity insertion in conjunction with a most positive Tech Spec MTC of $+0.5 \times 10^{-4}\ \Delta\rho/^{\circ}F$.

Question 5:

With the reduction of inward CEA deviation penalty factors to 1.0, the CPC will not provide a reactor trip on a CEA drop event. The analyses in FSAR Chapter 15.1.3 on CEA misoperation which result in reactor trip in all the cases analyzed are no longer valid. Provide the safety analysis on CEA misoperation to reflect the change in CEA penalty factors.

Response:

The analysis in FSAR chapter 15.1.3 illustrates a case where a reactor trip is generated for a CEA misoperation event which would otherwise cause the DNB SAFDL to be violated. This analysis was representative of the most limiting of trip and non-trip CEA misoperation events. The DNBR approached the DNB SAFDL. This analysis is still valid and the results given in this section are conservative. Later cycle specific setpoint analyses have shown

that the consequences of dropping a single CEA are not as adverse as described in the FSAR, so that a reactor trip is not required. Thus, the FSAR case shows a closer approach to the DNB SAFDL than would actually occur in the event of a single CEA drop. A representative system response for a CEA drop that does not require a trip was provided for SONGS at the time the CEA drop improvement program was implemented at SONGS (section 7.4.3 of the cycle 2 Reload Analysis Report).

Reference: M. O. Medford to G. W. Knighton, "Docket Nos. 50-361 and 50-362, Reload Analysis Report, San Onofre Nuclear Generating Station Units 2 and 3", September 28, 1984.