UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATING TO LOCA ANALYSES SUPPORTING OPERATION OF FORT CALHOUN STATION UNIT 1 WITH WESTINGHOUSE FUEL

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN STATION UNIT 1

DOCKET NO. 50-285

1.0 INTRODUCTION

In a letter dated September 30, 1991, as supplemented by a letter dated February 10, 1992, the Omaha Public Power District (OPPD) provided loss of coolant accident (LOCA) analyses for its Fort Calhoun Station, Unit 1, fueled with Westinghouse fuel assemblies co-resident with Combustion Engineering (CE) fuel assemblies.

2.0 STAFF EVALUATION

2.1 Plant Design

Fort Calhoun is a CE pressurized water reactor (PWR) with a two-loop nuclear steam supply system (NSSS). Each NSSS loop features a hot leg, a steam generator, and two cold legs. This is somewhat different than the Westinghouse configuration, which has one cold leg per loop. The Fort Calhoun LOCA analyses assume operation at a power of 1530 MWt, which is 102 percent of 1500 MWt.

2.2 Analysis Methodology

2.2.1 Analysis Model

The LOCA analysis methodology used for the Fort Calhoun LOCA analyses is described in WCAP-13027-P and WCAP-13028, "Westinghouse ECCS Evaluation Model for Analysis of CE-NSSS."

The large break model (BART for CE EM) in this methodology is based on the approved Westinghouse 1981 Evaluation Model with BART (BART EM), described in WCAP-9561-P-A. The most significant modifications made relative to models previously applied by Westinghouse to CE designs for this application are noding to reflect the differences between the Fort Calhoun CE NSSS design and the Westinghouse design, a metal heat modeling change, and data management changes (including the writing of a new special purpose code, REFBASH).

The Fort Calhoun LOCA analyses also include a usage change that terminates all safety injection tank (SIT) flow when the inventory in the first-emptying intact leg SIT is depleted. Westinghouse has indicated that this calculational feature stabilizes the thermal-hydraulic computations at the time of SIT depletion and for Fort Calhoun, has an insignificant impact on calculated event consequences (less than 0.5 seconds difference in SIT depletion time and less than 0.5 cubic feet of lost injected water).

From its review, the staff does not find the BART for CE EM acceptable for generic application at this time because of the code stability issue identified above and concern that it might introduce significant error in some future application. However, the staff finds that the model used for these Fort Calhoun large break LOCA analyses is in conformance with 10 CFR 50.46 requirements, applicable, and acceptable based on: (1) previous approvals of the technical analysis codes and the appropriateness of their integration into a composite model, (2) the appropriateness of the geometric and other modeling, and (3) the demonstrated insignificance of the impact of the model stabilization logic on calculated consequences. The small break LOCA model used for the Fort Calhoun analyses is based on the approved NOTRUMP EM described in WCAP-10054-P-A, Addendum 1, "Addendum to the Westinghouse Small Break Evaluation Model Using the NOTRUMP Code for the Combustion Engineering NSSS." Westinghouse made minor modifications to the NOTRUMP EM for CE to more appropriately model the CE NSSS. We find this model acceptable for Fort Calhoun small break LOCA analyses because it is based on an approved model, the modifications were minor, and the analyses demonstrate that small breaks are not limiting for Fort Calhoun with a margin of difference on the order of 900 °F.

2.2.2 Sensitivity Studies and Spectrum Analyses

OPPD provided a number of sensitivity studies and a break spectrum analysis to justify the initial and boundary conditions and break size used in the LOCA limits analysis.

The licensee assessed the impact of mixed fuel types in the core on calculated LOCA results and concluded that, because of the close similarity in thermal-hydraulic design, mechanical design, and neutronic design of the fuels, there is no mixed core penalty associated with either fuel type. NRC evaluations of the fuel assembly support the conclusion that no mixed core penalty is necessary. The licensee also performed a comparative evaluation of the two vendor fuel types over an appropriate range of power and burnup and concluded that the Westinghouse fuel was more limiting for the analyses. Of the Westinghouse fuel, that featuring Integrated Fuel Burnable Absorbers (IFBA) was identified as less limiting. Because there is no mixed core penalty, the analysis for Westinghouse non-IFBA fuel is considered the bounding analysis of record.

The licensee cited studies by both Westinghouse and CE to identify a double-ended cold leg guillotine (DECLG) break as the most limiting type and location of large break LOCA for Fort Calhoun. A range of axial core power distributions was studied to determine the limiting axial shape for the Fort Calhoun analyses. The results of a number of sensitivity calculations were presented to demonstrate that no loss of offsite power with minimum safeguards, is a limiting assumption for the Fort Calhoun large break LOCA analyses.

OPPD provided the results of large break spectrum analyses, which indicate that the limiting large break discharge coefficient (Cd) is 0.4.

OPPD provided the results of small break spectrum analyses, which indicate that the limiting small break is a .087 square foot cold leg break, yielding a calculated peak cladding temperature (PCT) of 1166 °F. This is about 900 °F below the large break spectrum. Therefore, small breaks are not limiting.

2.3 Limiting Case Results

The licensee provided the results for the limiting case Fort Calhoun LOCA analysis, a DECLG large break with Cd of 0.4. The analysis assumes the plant to be operating at 102 percent of its licensed power of 1500 MWt, a peak linear heat rate of 15.5 Kw/ft, a radial peaking factor of 1.80, and a maximum allowable peaking factor of 2.545 with the limiting axial power distribution as determined by its study identified above. The analysis assumes the plant is fueled with Westinghouse non-IFBA fuel, no loss of offsite power, and minimum safety injection flow. The analysis also assumes a 6 percent (uniform) steam generator tube plugging level. With these assumptions, the calculated PCT is 2066 °F, the maximum local metal/water reaction is 5.77 percent, and the total core-wide metal/water reaction is less than 1.0 percent. These results are within the criteria specified in 10 CFR 50.46(b)(1) through 50.46(b)(3) of 2200 °F, 17 percent, and 1 percent respectively. These results assure that the core will remain amenable to cooling as required by 10 CFR 50.46(b)(4), and the Fort Calhoun ECCS design as approved assures continued conformance with the long-term cooling requirement of 10 CFR 50.46(b)(5).

3.0 STAFF CONCLUSIONS

Based on our findings of acceptability of the ECCS evaluation model used in Section 2.2.1, inputs and assumptions in Section 2.2.2, and calculated results in conformance with the requirement of 10 CFR 50.46(b), we find the ECCS performance analyses for the limiting case of Westinghouse IFBA fuel for Fort Calhoun acceptable.

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