



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE OPERATION OF

YANKEE NUCLEAR POWER STATION

YANKEE ATOMIC ELECTRIC COMPANY

DOCKET NO. 50-29

1.0 INTRODUCTION

Section I.D.4 of Appendix K to 10 CFR Part 50 requires that the thermal-hydraulic interaction between steam and all emergency core cooling water shall be taken into account when calculating core reflooding rates. The currently approved Yankee Atomic Electric Company (YAEC) ECCS evaluation model for Yankee utilizes an additional frictional pressure drop (ΔP penalty) to account for the steam-water interaction effect. A ΔP penalty of 1.8 psid is utilized during the accumulator injection period; a penalty of 0.8 psid is used during the pumped injection phase.

In its August 16, 1985 letter, YAEC proposed to modify its ECCS evaluation model for Yankee by reducing the ΔP penalty from 0.8 psid to 0.15 psid during the pumped injection phase. The licensee's September 16, 1985 letter provided additional supporting information for the proposed model change.

This report presents our findings on the proposed modification.

2.0 EVALUATION

Since the time that the ΔP penalty utilized in the YAEC ECCS evaluation model was approved, tests have been performed by EPRI to examine the effects of steam-water interaction in the cold legs of a PWR. These tests were performed with 1/14 and 1/3 scale cold leg geometries and are discussed in EPRI reports EPRI-294-2, "Mixing of Emergency Core Cooling Water with Steam: 1/14 Scale Testing Phase" dated January 1975, and EPRI-294, "Mixing of Emergency Core Cooling Water with Steam: 1/3 Scale Test and Summary" dated June 1975, respectively. The testing program examined the cold leg pressure drop during both the accumulator injection phase and the pumped injection phase of the reflood portion of a large break LOCA.

In its August 16, 1985 letter, YAEC reported the results from all the EPRI tests during the pumped injection phase. Using the measured cold leg pressure drop data obtained during the EPRI experiments, YAEC derived the ΔP penalty associated with the steam-water interaction by subtracting out the piping frictional pressure drop. The mean of the pressure drop data indicated a pressure loss of -0.06 psi. The negative pressure drop indicates that the

ECC injection condenses the core steam and relieves the steam binding. YAEC's examination of the data indicated that the ΔP penalty could be bounded by 0.15 psid. Only one of the 131 data points was above 0.15 psid, and it did not replicate; the duplicate run for that data point had a pressure loss of 0.06 psid.

YAEC also examined the calculated reflooding parameters for the Yankee plant and compared them to the EPRI tests. With the exception of the ECC injection velocity, all the calculated conditions; e.g., core pressure, injected water temperatures, and steam momentum, were within the range of the EPRI tests. The EPRI tests varied the injection velocity between 1 and 16 ft/sec, while the Yankee injection velocities are 45 ft/sec. YAEC reported that the EPRI test results, and the supporting slip model developed in the June 1975 EPRI-294 report to predict cold leg pressure drops, shows that the ΔP penalty would decrease as injection rates increased.

In response to staff requests, YAEC examined the EPRI test results for the accumulator injection phase. These tests had been performed using injection velocities of 40 and 70 ft/sec. In its September 16, 1985 letter, YAEC presented the results of its review. Utilizing the 40 ft/sec injection cases, because they are typical of the 45 ft/sec injection velocity for Yankee, YAEC calculated the ΔP penalty for the tests. Of the 16 data points examined, 13 showed a zero or negative ΔP . All the tests were bounded by the proposed 0.15 psid ΔP penalty.

To further assure the adequacy of the proposed ΔP penalty, the staff performed calculations using the pressure drop model of the June 1975 EPRI-294 report for Yankee reflooding conditions. These calculations resulted in cold leg ΔP s of 0.05 psid and -0.04 psid at 50 and 150 seconds respectively.

Thus, based upon the EPRI test data and the staff calculations, we find the proposed ΔP penalty of 0.15 psid during the pumped ECC injection period to be acceptable.

3.0 CONCLUSION

YAEC has proposed to modify the ECCS evaluation model for Yankee by reducing the ΔP penalty from 0.8 psid to 0.15 psid, during the ECC pumped injection phase of the reflood transient, to account for steam-water interaction effects. Based upon the EPRI test data and independent staff calculations, we find the proposed ΔP penalty meets the requirements of Section I.D.4 of Appendix K to 10 CFR Part 50. Accordingly, we approve the proposed modification to the ECCS evaluation model for Yankee.

4.0 ACKNOWLEDGEMENT

This Safety Evaluation was prepared by R. Jones.

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