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Director, Nuclear Reactor Regulation
Att Mr Dennis M Crutchfield, Chief
Operating Reactors Branch No 5
US Nuclear Regulatory Commission
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PALISADES PLANT - SEP TOPIC IX-4, BORON ADDITION SYSTEM

Enclosed is the Consumers Power Company evaluation of SEP Topic IX-4 for the Palisades Plant.

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SYSTEMATIC EVALUATION PROGRAM BRANCH
TOPIC IX -4, BORON ADDITION SYSTEM
PALISADES PLANT

I. INTRODUCTION

Following a LOCA, boric acid solution is introduced into the reactor vessel by two modes of injection. In the initial injection mode, borated water is provided from the refueling water storage tank. After this initial period, which may last somewhere between 20 - 60 minutes, the Emergency Core Cooling System (ECCS) is realigned for the recirculation mode. In this mode borated water is recirculated from the containment sump to the reactor vessel and back to the sump through the break. A portion of the water introduced into the reactor vessel is converted into steam by the decay heat generated in the core. Since the steam contains virtually no impurities, the boric acid content in the water that was vaporized remains in the vessel. The concentration of boric acid in the core region will therefore continuously increase, unless a dilution flow is provided through the core. Without the dilution flow the concentration of boric acid will eventually reach the saturation limit and any further increase in boric acid inventory will cause its precipitation. Boric acid deposited in the core may clog flow passages and seriously compromise the performance of the ECCS. Topic IX-4 is intended to review the boron addition system, in particular with respect to boron precipitation during the long term cooling mode of operation following a loss of coolant accident, to assure that the ECCS is designed and operated in such a manner that a sufficient throughflow is provided before the concentration of boric acid will reach its saturation limit.

II. Review Criteria

The plant design was reviewed with regard to Appendix A, 10CFR Part 50, General Design Criteria - 35, "Emergency Core Cooling", which requires that a system to supply abundant emergency core cooling shall be provided. In addition, the plant design was reviewed with regard to 10CFR 50.46, "Acceptance Criteria for Light Water Nuclear Power Reactors", and Appendix K to 10CFR Part 50 "ECCS Evaluation Models", which set forth the requirements to maintain coolable core geometry and to provide long-term core cooling: the basis for the boron precipitation reviews.

III. RELATED SAFETY TOPICS

Topic VI-7.A.3 reviews the ECCS actuation system with respect to the testing for operation and design performance of each component of the system. Topic VI-7.B reviews the procedures for ESF switchover from injection to recirculation mode.

IV. REVIEW GUIDELINES

There are no unique SRP sections that deal with this issue. The primary criterion used for review of this system was discussed in a memo dated January 21, 1976 entitled, "Concentration of Boric Acid in Reactor Vessel During Long Term Cooling-Method for Reviewing Appendix K Submittals."

V. EVALUATION

Control of the reactor system boron concentration, which is responsible for normal reactor shutdown, is provided by the Chemical and Volume Control System. This is accomplished by pumping borated water from either the Safety Injection and Refueling Water Tank (SIRWT) or either of the Concentrated Boric Acid Tanks (CBAT). The quantity of boric acid in the SIRWT and in each CBAT is sufficient to borate the PCS to cold shutdown conditions at any time during core life.

There are two flow paths to the PCS for each of the three borated water sources. The water from each CBAT can be either gravity fed or pumped by boric acid pumps to the charging pumps suction. The water from the SIRWT can be either gravity fed to the charging pump suction or can be pumped directly into the PCS using the HPSI pumps. This level of redundancy provides for required PCS boration coincident with any active single failure.

Concern was raised by the NRC that boron precipitation could occur and impair the ability of the boron addition systems to maintain safe core cooling following a loss-of-coolant accident. Following a break, decay heat is removed by boiloff of water in the core. As water is evaporated, the concentration of boron can reach the saturation point causing precipitation of boron in the core. Without a flushing flow through the core, the precipitation could result in blockage of core channels. The safety objective is to assure that the potential for significant boron precipitation that would restrict core flow is eliminated by establishing such a flushing flow.

To prevent this buildup and precipitation of boron in the core during the long term recirculation mode, Palisades utilizes simultaneous hot leg and cold leg injection following large LOCA's. As described in Ref (1) the HPSI pumps inject water into the four cold leg ECCS nozzles as well as simultaneously into loop 1 hot leg. For small LOCA's the PCS refills and decay heat is removed via the steam generators and shutdown cooling system. After refilling there is no steaming thus removing the mechanism for boron precipitation. If these systems are not available, energy is removed via the PORV's with HPSI injection providing adequate flushing flow. Although there are separate procedures for large and small breaks the applicable break sizes for each procedure sufficiently overlap thus eliminating the possibility of the operator selecting the improper procedure.

The analysis presented in reference (1) shows that there is sufficient margin between the saturation boron concentration and the maximum attainable for both small and large break LOCA's. The limiting break is the double-ended cold leg break. However, even with no flushing flow boron precipitation does not occur for 29 hrs (long term cooling and hence prevention of boron precipitation procedures commence at 5½ to 6½ hrs.) With only a 5 gpm flushing flow the peak calculated boron concentration is about 10% less than the saturation concentration. Actual expected flushing flows are expected to be much greater than 5 gpm with a resultant increased margin.

VI. CONCLUSION

Based upon the above review it is concluded that the boron addition system at Palisades is acceptable.

References

1. Letter from B D Johnson, CPCo, to D M Crutchfield, USNRC, dated October 9, 1981, Long Term Cooling Equipment Modification Design Report.