July 16, 1981

Docket No. 50-206
LS05-81- 07-048

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U.S. NUCLEAR REGULATORY COMMISSION

Mr. R. Dietch, Vice President
Nuclear Engineering and Operations
Southern California Edison Company
2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770

Dear Mr. Dietch:

SUBJECT: SEP TOPIC IX-4, BORON ADDITION SYSTEM
SAN ONOFRE

Enclosed is a copy of our final evaluation of SEP Topic IX-4. This evaluation incorporates comments provided to us by your letter dated June 25, 1981. We now consider this evaluation to be final.

This evaluation will be a basic input to the integrated safety assessment for your facility unless you identify changes needed to reflect the as-built conditions at your facility. This topic assessment may be revised in the future if your facility design is changed or if NRC criteria relating to this topic are modified before the integrated assessment is completed.

Sincerely,

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

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Enclosure:
As stated

cc w/enclosure:
See next page

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NRC FORM 318 (10/80) NRCM 0240 **OFFICIAL RECORD COPY** USGPO: 1980—329-824

Mr. R. Dietch

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SYSTEMATIC EVALUATION PROGRAM BRANCH
TOPIC IX-4, BORON ADDITION SYSTEM
SAN ONOFRE 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 using either one of the two charging pumps or the test pump (Chemical and Volume Control System test pump installed in parallel with the charging pump) to inject concentrated boric acid solution into the reactor coolant system. There are two sources of borated water available for injection through three different paths as follows:

1. The boric acid injection pump can deliver the boric acid tank contents to the charging pump and/or test pump.

2. Boric acid transfer pumps can deliver the boric acid tank contents to the charging pumps and/or test pump.

3. The charging pumps and the test pump can take suction directly from the refueling water storage tank (3750 ppm boron).

The quantity of boric acid in storage from the above two sources is sufficient to borate the reactor coolant system in order to reach cold shutdown at any time during the core life. Furthermore, if the letdown capability from the primary coolant system to the chemical and volume control system should be impaired the pressurizer void space volume is sufficient to accommodate the required injection. This free volume will accommodate sufficient concentrated boric acid solution such that the reactor coolant water can reach a concentration of about 400 ppm above the required level to shut the plant down during normal operation.

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. In response to requests by the NRC in letters dated March 18, 1975, Southern California Edison Company (SCE), the licensee for San Onofre Unit 1, has evaluated the potential for boron precipitation during long term core cooling following a loss-of-coolant accident (LOCA). After a cold leg 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. Progress in the evaluation of this potenial and development of systems and procedural modifications to prevent its occurrence have been reported to the Commission by the licensee in letters dated November 14, 1975, March 16, 1976, and May 11, 1976.

To prevent this buildup and precipitation of boron in the core during the long term recirculation mode following a LOCA, SCE utilizes a dual recirculation pattern (Dual Recirculation) involving both the cold legs (Recirculation System) and the hot legs (Hot Leg Recirculation System). For long term cooling, the Recirculation System is supplied with borated water from the sump and injects into the cold legs while the Hot Leg Recirculation System provides an additional means of adding borated water to the reactor coolant system by flow from the sump, through the charging pumps and then through the pressurizer auxiliary spray to the loop "B" hot leg. Upon initiation of Dual Recirculation (19 hours after the LOCA), the required flow split between the cold and hot legs is established by manipulating the flow control valves in the recirculation and hot leg recirculation systems.

At the present time, several single failures could prevent, or at least reduce, flow through the Hot Leg Recirculation System. An acceptable modification to prevent these single failures involved the installation of redundant valves in the path to the loop B hot leg. SCE, in their letter dated August 10, 1978, as supplemented by letter dated September 15, 1978, submitted a proposal to postpone the implementation of four ECCS single failure modifications to permit evaluation of the potential impact of other plant modifications which may be considered as part of the integrated assessment of the facility in the Systematic Evaluation Program (SEP). Postponement of the above modification was granted by the NRC in a letter dated October 16, 1978. Until these modifications can be made, a means to provide adequate hot leg recirculation in the unlikely event of a loss-of-coolant accident in one of the cold legs and the single failure of one of the valves in the hot leg recirculation path has been developed.

This alternate hot leg recirculation flow (see Reference 1) will provide borated recirculation water to loop "C" hot leg of the reactor coolant system via the residual heat removal letdown line bypassing the RHR pump, rather than through the pressurizer spray to hot leg "B" (see Figure 1). Thus, a single failure will not prevent Dual Recirculation.

The suitability of Dual Recirculation initiation time has been established by analysis. Results of conservative calculations (assuming no depletion of boric acid in the core region due to any mechanism and with appropriate conservatisms in the decay heat source) indicate that the boric acid inventory in the core will approach the saturation point 27.8 hours following a LOCA. The proposed initiation of Dual Recirculation at 19 hours therefore occurs well before precipitation.

The adequacy of flow rates to the core during Dual Recirculation has also been confirmed by analysis. Flow rates to the core were evaluated for Dual Recirculation operation with various postulated large break LOCAs (as discussed in Reference 2, the large cold-leg LOCA is the limiting case from the standpoint of boron precipitation). The analysis indicated that with modifications to eliminate unacceptable single failures completed, at least 13.7 lbm/sec (102 gpm) will be available to the core compared with the maximum calculated boil-off rate of 8.8 lbm/sec. Therefore, more than adequate flow to the core is available during Dual Recirculation (Reference 3).

VI. CONCLUSION

Based on our review and using staff criteria referenced earlier, we conclude that the staff analysis of the dual recirculation documented in Amendment No.25 is judged to be acceptable. However, as stated in the SE the licensee has postponed the implementation of ECCS single failure modifications to this system pending their evaluation of the impact of other plant modifications as part of the Systematic Evaluation Program on the ECCS single failure modifications. This delay will have no effect on plant safety since an alternative flow path has been developed in the interim. A schedule for the implementation of these ECCS single failure modifications will be considered during the integrated assessment.

REFERENCES

1. Letter dated October 16, 1978 from D. Ziemann of USNRC to Mr. James H. Drake, SCE.
2. Letter CLC-NS-309, dated April 1, 1975, from Mr. C. L. Caso of Westinghouse to Mr. T. M. Novak of USNRC.
3. Letter dated December 21, 1976 from K. P. Baskin (SCE) to Mr. Albert Schwencer, USNRC.
4. Letter dated March 25, 1977 from SCE to the USNRC.
5. Letter dated April 1, 1977 from USNRC (Amendment No. 25) to SCE.

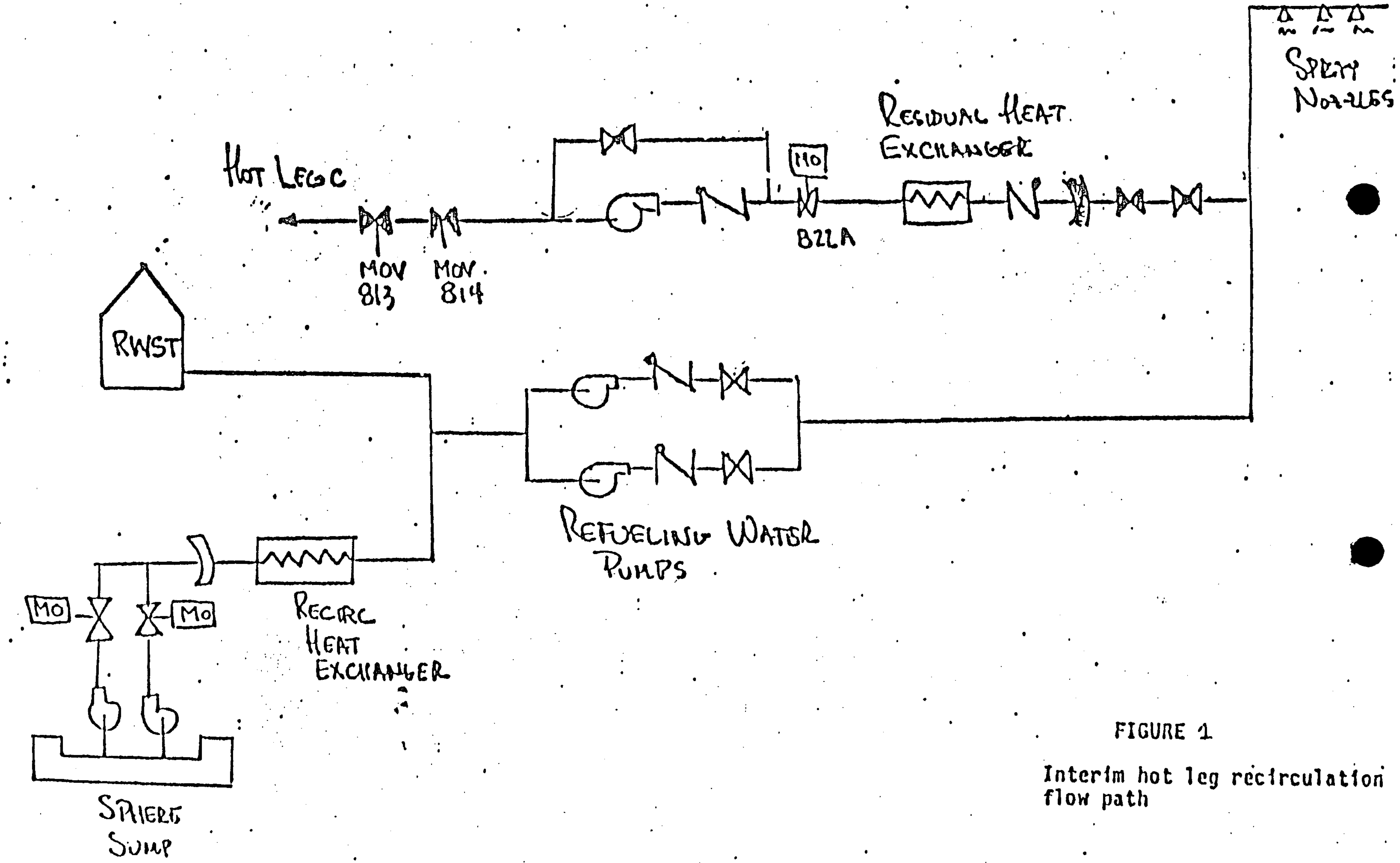

FIGURE 1

Interim hot leg recirculation flow path