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SUBJECT: Responds to requests for addl info re 860124 Proposed Change (PCN-3) to License NPF-10, reducing Mode 6 shutdown cooling sys flow requirements from 4,000 to 2,200 gpm. Recirculation actuation signal setpoint not lowered.

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April 11, 1986

Director, Office of Nuclear Reactor Regulation
Attention: Mr. George W. Knighton, Director
PWR Project Directorate No. 7
Division of PWR Licensing - B
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Subject: Docket Nos. 50-361 and 50-362
San Onofre Nuclear Generating Station
Units 2 and 3

Southern California Edison Company's (SCE) letter dated January 24, 1986 submitted Proposed Change NPF-10/15-3 (PCN-3). PCN-3 would reduce mode 6 shutdown cooling system flow (SDCS) requirements from 4000 gpm to 2200 gpm. The Staff has raised several questions relating to PCN-3. The responses to these questions are attached.

If you have any questions regarding this information, please call me.

Very truly yours,

M. O. Medford

cc: Harry Rood, NRC (to be opened by addressee only)
F. R. Huey, USNRC Senior Resident Inspector,
Units 1, 2 and 3

A001
1/1

NRC QUESTIONS RELATING TO PCN-3

Question

1. On pg. 1, Lines 30, it is stated that: "This high flow rate (4000 gpm) necessitates maintaining a high water level (greater than or equal to 23′ above the reactor pressure vessel flange) in the RCS (reactor coolant system) to prevent vortexing in the SDCS suction." Provide the bases for SCE's understanding that vortexing will occur if the proposed repair is made during Mode 6 and the minimum Shutdown Cooling System (SDCS) flow of 4000 gpm is observed. For example, has vortexing been observed in the SDCS suction under these conditions, or is vortexing expected based upon some calculations?

Response

Vortexing in the shutdown cooling system suction (SDCS) has been observed with the RCS at mid-loop. On March 14, 1982, while in Mode 6, a temporary loss of shutdown cooling was experienced due to a large gas bubble in the low pressure safety injection (LPSI) pump suction. This event is documented in Licensee Event Report (LER) No. 82-03. This event resulted from the introduction of pressurized nitrogen into the SDCS pump suction line. This occurred during back flushing of a filter in the purification system. In the course of the review of this event to determine its cause, it was hypothesized that vortexing had occurred in the SDCS suction while the RCS was at low water level, drawing air into the suction. To validate this hypothesis, a special test was run to determine whether this occurred. After venting the system high point, one LPSI pump was run for eight hours at a flow rate of 4200 gpm. A pressure gauge indicated a vacuum of 2 1/2" of Hg at the suction high point. The pump was stopped and the system vented. Gas was vented from both the penetration area and suction high point vents indicating that vortexing had occurred at the SDCS suction. The test was then repeated with flow throttled to 3000 gpm. Pressure at the high point vent was one psig positive. After eight hours of operation, the pump was stopped and the system vented. An insignificant amount of gas was released indicating that a lower SDCS flow would alleviate the problem.

Question

2. On pg. 2, lines 19-21, it is stated that "Regardless of the minimum SDCS flow requirement, the Mode 6 requirement for maintaining RCS temperature below 140^{o}F will determine actual SDCS flow rate." Provide an analysis that shows that a minimum SDCS flow rate of 2200 gpm is sufficient to maintain RCS temperature below 140^{o}F while in Mode 6.

Response

A calculation was performed to justify that a minimum SDCS flow rate of 2200 gpm is sufficient to maintain RCS temperature below 140^{o}F while in Mode 6 following an elapsed time of 360 hours or greater since shutdown. In general, following normal shutdown and refueling procedures, more than 360 hours will lapse between reactor shutdown and when it is desired to partially drain the RCS. Additionally, should entry into Mode 6 be made prior to 360 hours the 140^{o}F Mode 6 upper limit on temperature will govern the shutdown cooling system flow rate. A heat balance was performed considering heat inputs such as decay heat, primary system metal mass heat and LPSI pump heat.

The assumptions used in this calculation are as follows:

1. Only one LPSI pump and one shutdown cooling heat exchanger (SDC HX) are being used.

2. The decay heat values are consistent with the decay heat curve used in LOCA analyses (see FSAR Section 6.3.1.2).

3. The decay heat value is calculated at 360 hours after reactor trip.

4. The core is assumed to be at 100% power (3390 MWt) prior to shutdown.

5. Heat losses to ambient are neglected.

6. The SDC HX is modeled as a counterflow heat exchanger with one shell pass and two tube passes.

7. The SDC flow meter has an uncertainty of +2% of the span, or +200 gpm. Therefore, 200 gpm is subtracted from the assured 2200 gpm SDC flow rate for conservatism.

The results of the calculation show that the heat removal capacity of the shutdown cooling system under the assumed conditions is greater than the quantity of heat inputs of the RCS. Therefore, the RCS temperature can be maintained below 140°F.

Question

3. The SCE submittal dated January 24, 1986 indicates that SONGS 2 & 3 will be operated with a partially drained RCS in Mode 6, and with a minimum SDCS flow rate of 2200 gpm. In Chapter 15.4.1.4, "CVCS Malfunction (Inadvertent Boron Dilution)", it is not clear that boron dilution events were evaluated for a partially drained RCS in Mode 6. Provide the previous Mode 6 analysis that was referenced (but not described in detail) in the FSAR (p. 15.4-29, lines 4 to 6) unless a new analysis is to be provided (see the following). State whether the previous Mode 6 analysis was based on a partially drained RCS (e.g., the 4262 ft^3 used in the unique Mode 5 analysis, FSAR, p. 15.4-33) or a filled RCS (e.g., 10,256 ft^3, FSAR, p. 15.4-32). In addition, state whether the previous Mode 6 analysis was based on operation of 1 or 3 charging pumps, (Note that p. 3, lines 40 and 41 are not explicit on this item, and a reference is made to a non-existent Chapter 15.4.1.4 of the FSAR). If the previous Mode 6 analysis was based on a RCS filled, then provide a new analysis of the inadvertent boron dilution event for Mode 6 instead of the analysis referred to in Ch. 15.4.1.4.1. The new analysis should include:

(1) The indications and/or alarms that are available to alert the operator that a boron dilution event is occurring in Mode 6.

(2) The actions that the operator will use to terminate the boron dilution process. If the actions for terminating a boron dilution event while in Mode 6 are the same as those listed for Mode 5 (see FSAR 15.4.1.4.2.B), then SCE should merely refer to FSAR 15.4.1.4.1.B.

(3) The equation(s) used to estimate the time "T" required to dilute to criticality if eq. 3 of FSAR 15.4.1.4.3 is not to be used.

(4) The input parameters and initial conditions for use in the equation identified in response to the preceding question. In particular, provide the bases for estimating the critical boron concentration for Mode 6, and the inverse boron worth for Mode 6.

(5) The estimated time interval from the start of boron dilution to criticality.

(6) The estimated time interval from the start of boron dilution to initiation of each indicator and/or alarm identified in response to the preceding question (i.e., #3(1)).

(7) The estimated time intervals from the indications and/or alarms to the time when the core would go critical.

Response

For the CVCS malfunction (Inadvertent Boron Dilution) event presented in the FSAR, boron dilution events were analyzed during each of the six plant operational modes. The FSAR, also referred to as the reference analysis, corresponds to Cycle 1 of operation. Boron dilution event during Mode 5 operation with three charging pumps operating was found to be the limiting case and was presented in Section 15.4.1.4 of the FSAR. The Mode 6 analysis was performed for a partially drained RCS with three charging pumps operating. A conservatively low RCS volume, 3029 cubic feet, was assumed in the analysis. In Mode 6 operation, the technical specification RCS boron concentration is relatively high (more restrictive of the two conditions to be met: Keff less than or equal to 0.95 or boron concentration greater than or equal to 1720 ppm) compared to the critical boron concentration. Hence, the time to criticality for Cycle 1 was significantly higher than the time calculated for the limiting Mode 5 case, even with three charging pumps operating.

The Inadvertent Boron Dilution event was reanalyzed using SONGS Cycle 3 data and was presented in Section 7.4.4 of the SONGS 2 Cycle 3 Reload Analysis Report (RAR). The method used for the analysis of Cycle 3 inadvertent boron dilution event was the same as the method presented in Section 15.4.1.4 of the FSAR. The time "T" required to dilute to criticality was estimated using equation 3 of FSAR Section 15.4.1.4.3. The Mode 6 analysis in the RAR was performed for a partially drained RCS as in the FSAR with the exception that only one charging pump was assumed to be operating. This assumption is consistent with the plant operating procedures which will permit a maximum of one charging pump operating during the period when the RCS is partially drained, with power removed from the remaining two pumps. The indications and/or alarms that are available to alert the operator that a boron dilution event is occurring in Mode 6, and the actions that the operator will use to terminate the boron dilution process are the same as those listed in the FSAR Section 15.4.1.4.2. The minimum estimated interval from the start of boron dilution to the time of criticality was calculated to be greater than 60 minutes.

Question

4. If credit for administrative controls regarding the use of only one charging pump is taken in the previous or new analysis of a boron dilution event in Mode 6, then describe these procedures and verify that operators are trained to use them.

Response

Credit is taken for administrative controls to ensure that a maximum of one charging pump can contribute to a boron dilution event in the Modes 5 and 6, Cycle 2 and Cycle 3 Reload Analyses. These administrative controls have been in place since initial operation of Units 2 and 3 and are documented in Operating Procedures:

1) SO23-5-1.8 "Shutdown Operations (Modes 5 and 6)"

2) SO23-3-2.8.1 "Refueling Cavity Draining Operations."

3) SO23-3-1.8 "Draining the Reactor Coolant System"

4) SO23-3-3.26.1 "Once a Day Surveillance (Modes 5 and 6)"

These procedures require that the power be removed from two charging pumps during these operations. Additionally, valves for demineralized water sources that could enter the RCS through a deactivated charging pump are tagged closed. Operators are trained and have implemented these procedures on a routine basis when the plant has been in cold shutdown or refueling.

Question

5. The SCE submittal indicates that vortexing will occur in the suction of the SDCS for flow rates of 4000 gpm and partially filled RCS. State whether vortexing is expected to occur in the suction of the SDCS while drawing water from the refueling water storage tank following a loss of coolant accident. Provide the bases (e.g., flow paths, flow rates and available heads) for SCE's position.

Response

In response to this question, it must be clarified that the shutdown cooling system (SDCS) does not take suction from the refueling water storage tanks (RWST) either during post accident conditions or normal operating conditions. The design suction flow path for the shutdown cooling system draws reactor coolant from the RCS loop 2 hot leg. However, during the initial phase, the injection phase, of safety injection system operation following a loss of coolant accident, the pumps which function as the SDCS pumps are used in their design function for low pressure safety injection (LPSI). In this mode, the LPSI pumps are drawing off the RWST. The total suction demand from one of the refueling water storage tanks in this phase is the combined suction flow of one LPSI pump, one high pressure (HPSI) pump and one containment spray pump (assuming CIAS occurs concurrently).

The potential for vortexing in the safety injection system RWST suction, during the period of greatest suction demand, was reviewed in conjuction with consideration of lowering the Recirculation Actuation Signal (RAS) setpoint. The results have indicated that at the conclusion of valve realignment (the shift from the injection phase to the recirculation phase) the RWST final level would not result in vortex formation into the tank suction nozzle even with a lower RAS setpoint. The RAS setpoint has not been lowered. Therefore, the current RAS setpoint and resultant final RWST level provides additional conservatism to assure that vortexing would not occur.