SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT ☐ 6201 S Street, Box 15830, Sacramento, California 95813; (916) 452-3211

RJR 83- 666

September 21, 1983

DIRECTOR OF NUCLEAR REACTOR REGULATION
ATTENTION JOHN F STOLZ CHIEF
OPERATING REACTORS BRANCH 4
US NUCLEAR REGULATORY COMMISSION
WASHINGTON DC 20555

DOCKET 50-312
RANCHO SECO NUCLEAR GENERATING STATION
UNIT NO 1
NATURAL CIRCULATION COOLDOWN INFORMATION

Your letter of May 25, 1983, requested additional information for your review of our use of natural circulation cooldown procedures. The District's responses to your questions follow:

QUESTION 1: Provide a detailed description of your natural circulation cooldown procedure and its basis (it should include guidance on possibility, prevention and mitigation of upper head voiding and natural circulation interruption.

RESPONSE 1: The procedures used at Rancho Seco to address handling a natural circulation cooldown and actions to be taken if such a cooldown is interrupted are OP B.4 Section 6 and Casualty Procedure C.48, respectively. These procedures are based on B&W Guidelines for Small Break LOCA, B&W Guidelines for Use of High Point Vents and the B&W draft Abnormal Transient Operator Guidelines (ATOG) for Rancho Seco. Also, plant operating experience by B&W Owners provides additional basis for the procedures that have been developed. Below is a detailed description of both procedures:

OP B.4 Section 6 Natural Circulation Cooldown

The operator is directed to this procedure anytime all 4 reactor coolant pumps (RCP's) are lost. His first actions are to verify auxiliary feedwater (AFW) flow starts, once through steam generator (OTSG) levels are maintained, and the reactor coolant system (RCS)

A057 1/0

is ≥ 50° subcooled and RCS ΔT is ≤100°F. If any of these conditions are not met, high pressure injection (HPI) core cooling is initiated and the operator is referred to Casualty Procedure C.48.

If the above conditions are met, then natural circulation should be established. The operator next verifies natural circulation by:

1. T_h and incore T/C's rise ~35° above Tc (normal full power trip).

2. $Tc \approx T_{sat}$

3. Tc tracks changes in T_{sat}

4. T_h and incore T/C's track changes in T_{sat}

If subcooled natural circulation cannot be verified, the operator is again directed to C.48.

If subcooled natural circulation is verified, the operator is directed to maintain the plant in hot shutdown conditions, if plant conditions allow, until RCP's are available so a forced circulation cooldown can be performed. A forced circulation cooldown will eliminate concerns of void formation (reactor vessel (RV) head or candy canes).

If RCP's are not available and a natural circulation cooldown is required, the operator is directed to cooldown/depressurize as slowly as plant conditions allow. This again minimizes the possibility of void formation in the RV head region. The depressurization is to be in steps not to exceed 75-100 psi. This ensures that if a void is formed in the RV head region, its size will be kept to a minimum.

The operator is cautioned on methods of recognizing void formation in the RCS. Indications are:

1. A sudden increase in pressurizer level or makeup tank level while pressure is constant or decreasing.

2. Unexpected pressurizer level changes during makeup or spray operation.

If void formation is suspected, the operator is directed to stop depressurization and repressurize the RCS to the maximum allowed by the cooldown curve in use at the time (Technical Specification curve or Interim Brittle Fracture curve). Continued cooldown/depressurization is not to continue unless absolutely necessary. If necessary to continue cooldown with suspected RV head void, it should be done as slowly as possible with very close observation of continued natural circulation. If RCS subcooling drops to ≤50°F <u>or</u> RCS ΔT approaches 100°F, (indicates probable loss of natural circulation due to void blockage in the candy canes), the operator is directed to C.48 to regain natural circulation. Otherwise, a normal natural circulation cooldown is continued.

C.48 Losses of Subcooled Natural Circulation

The first thing the operator is directed to do is verify the RCS is not superheated. If any superheat is indicated, he is directed to Casualty Procedure C.47 Inadequate Core Cooling.

If superheat conditions do not exist, the operator verifies HPI core cooling is operating (since OTSG cooling does not exist).

The operator is then directed to maintain RCS pressure to ≤ 2300 psig or below the Interim Brittle Fracture curve by opening the EMOV. This repressurization of the RCS would occur during certain size small break LOCA conditions where the energy removal out the break is less than decay heat generation in the core.

Next the operator is directed to verify AFW flow or regain if none exists. AFW is needed to regain natural circulation.

With AFW established, the operator can then attempt to re-establish subcooled natural circulation by the following:

1. Increase secondary side cooling:

   a. Increase AFW flow ≥ 400 gpm total flow

   b. Raise OTSG levels to 95% on Operate Range. (The above 2 steps address the B&W concern that adequate core cooling is provided through the boiler-condenser mode of heat transfer during certain size small break LOCA's with only one HPI train operable.)

   c. Increase OTSG steaming rates by use of turbine bypass or atmospheric dump valves.

If subcooled natural circulation is re-established, the operator is directed to OP B.4 Section 6.

If natural circulation is not re-established, the RCP's are to be bumped, if they are available. Bumping the RCP's will force any voids in the candy canes into the OTSG's where they can be condensed. Each RCP is "bumped" once for 10 seconds with 15 minutes between bumps. After the RCP's are each bumped once, if subcooled natural circulation can be verified, the first RCP bumped, is to be started and run continuously to provide for a forced circulation cooldown. After bumping the pumps, if subcooled natural circulation cannot be verified, this would indicate either that the voids are non-condensibles or there is an RCS inventory problem. In either case, the RCP's should not then be run. (The operator is cautioned to the fact that natural circulation may be difficult to verify with HPI core cooling in operation. One method is that incore T/C's show a decrease in temperature when OTSG pressure is decreased while HPI flow is kept constant. This indicates that the primary and secondary are coupled.)

If the RCP's are unavailable or subcooled natural circulation cannot be verified following RCP bumps, then the RCS hot leg high point vents are to be opened. Opening these vents will allow voids trapped in the hot legs to be vented and allow the hot legs to be refilled with subcooled water which will promote re-establishment of subcooled natural circulation. Once the high point vents are opened, they are to remain open until:

1. The RCS depressurizes sufficiently so low pressure injection (LPI) core cooling is adequate, or

2. Subcooled natural circulation is verified.

QUESTION 2: Demonstrate by analysis or otherwise, that:

a) Use of procedures will not result in upper head voiding;

b) If voiding occurs, your procedures will prevent voiding at the hot leg elevation and if voiding does occur, at this elevation, your procedures adequately address interrupted natural circulation.

RESPONSE 2: a) The procedures described in our response to Question 1 identify how to detect void formation in the RCS and what actions are to be taken to collapse the void. There is no need for analysis or other work to show that upper head voiding does or does not develop since the procedures describe actions for either case that may occur.

b) The procedures described in our response to Question 1 identify what actions are necessary if voiding occurs to the extent of interrupting natural circulation. There is no need for analysis or other work to show that hot leg voiding does or does not develop since the procedures describe actions for either case that may occur. Additionally, due to the natural circulation flow leaving only the upper head region stagnant, no hot leg voiding should occur until gross upper head voiding has taken place. Should the upper head bubble grow large enough to enter the hot leg flow stream it would be quickly collapsed as it swept through the steam generator.

QUESTION 3: An analysis that shows you have sufficient condensate supplies to support a conservative estimate of the time to reach the Decay Heat Removal System entry conditions.*

* The Reference 4 report makes the following conclusions:

a) A cooldown without voiding will take a minimum of 84-130 hours.

b) 30 hours are required to collapse a 458 ft^3 steam bubble at 2000 psig during an isobaric process. (Raising RCS pressure to accelerate bubble condensation is not an effective mechanism for rapid bubble collapse.)

RESPONSE 3: As stated in Sections 10.2.2.B and 14.1.2.8.4.D the AFW system has a 24 hour supply of condensate water from the condensate storage tank, as a minimum, with backup supplies from the Folsom South Canal pumps (unlimited supply) and the plant reservoir. It is not expected that Rancho Seco would be without offsite power for more than 24 hours (creating the need for natural circulation cooldown) due to District dispatcher procedures and ties to two hydroelectric units and a 230 KV transmission line. Even with the assumption that natural circulation cooldown is required beyond 24 hours the other sources of cooling water mentioned above will more than suffice.

Water supply capacities include 800 million gallons of water in the plant reservoir piped to the AFW suction line. Also, the capability to rig the diesel fire pump (2000 gpm capacity) to the 2 million gallon plus circulating water canal exists. The Rancho Seco plant can call in portable demineralizers (trailer mounted) in about 4 hours to supply condensate grade makeup before the need arises to go to the plant reservoir or circulating water canal. Based on the above diverse means of supplying water to the AFW system, Rancho Seco can go to cold shutdown with a loss of offsite power at a cooldown rate that precludes void formation in the RCS.

William K. Latham

William K. Latham
Acting General Manager