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Mr. George W. Knighton, Chief
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Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

South Texas Project
Units 1 and 2
Docket Nos. STN 50-498, STN 50-499
Responses to DSER/FSAR Items
Concerning Boron Dilution

Dear Mr. Knighton:

The attachments enclosed provide STP's response to Draft Safety Evaluation Report (DSER) or Final Safety Analysis Report (FSAR) items.

The item numbers listed below correspond to those assigned on STP's internal list of items for completion which includes open and confirmatory DSER items, STP FSAR open items and open NRC questions. This list was given to your Mr. N. Prasad Kadambi on October 8, 1985 by our Mr. M. E. Powell.

The attachments include mark-ups of FSAR pages which will be incorporated in a future FSAR amendment unless otherwise noted below.

The items which are attached to this letter are:

Attachment	Item No.*	Subject
1	D 15.4-3 (F 15.4-1, Q440.67, Q440.68)	Boron Dilution Analysis Note: Responses to these questions provide information regarding the analysis to be performed. The responses will be updated upon completion of the analysis

* Legend
D - DSER Open Item
C - DSER Confirmatory Item
F - FSAR Open Item
Q - FSAR Question Response Item

L1/DSER/aas

B001
1/1

If you should have any questions concerning this matter, please contact Mr. Powell at (713) 993-1328.

Very truly yours,

M. R. Wisenburg
Manager, Nuclear Licensing

JSP/bl

Attachments: See above

Ll/DSER/aas

cc:

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L1/DSER/aas

Question 440.67N

Provide the following information with regard to the "CVCS Malfunction that Results in a Decrease in Boron Concentration in the Reactor Coolant" analysis:

a. For each operational mode, list the alarms and indications that would alert the operators to the occurrence of a BDE, and verify their redundancy. Also describe any automatic mitigation systems. Confirm that your technical specification will require two alarms to be operable during all shutdown and refueling modes.

b. The FSAR states that the maximum dilution flow during startup and hot standby is 382 gpm based on operation of two reactor makeup water (RMW) pumps while the RCS is at 2250 psi. For this dilution flow rate, the minimum time for loss of shutdown margin is 19.6 minutes.

   1. Please confirm that you will impose technical specification limits to ensure that RCS pressure, when accounting for instrument error, will not be dropped below 2250 psi in either of these two modes.

   2. Please provide analyses of boron dilution events in Modes 4, 5, and 6. How do you intent to ensure RCS pressure never drops below the pressure corresponding to the maximum dilution flow assumed in your analysis? Our concern is that the SRP Section 15.4.6 criterion of 15 minutes (30 minutes for Mode 6) for minimum time availability before shutdown margin is lost will be met with maximum dilution flows assuming operation of two charging pumps and two RMW pumps at minimum RCS pressure for the particular mode analyzed.

c. The FSAR states that valve CV0298 in the CVCS will be locked closed during refueling. Discuss whether additional valves should also be locked closed for redundancy.

Demonstrate that all possible dilution flow paths have locked closed valves, and confirm that the tech specs will contain this information.

Response

a. The following information describes the alarms and indicators available to alert the operators to the occurrence of a boron dilution event.

   There are several different alarms/indicators which would alert an operator of a boron dilution event at STP, including those as follows:

   1. Source Range Neutron Flux High Flux Level Alarm - When the reactor is subcritical (Modes 3, 4, 5 & 6), the high flux level at shutdown alarm is visually and audibly annunciated in the control room when the setpoint is reached. The audible alarm is also given inside the containment as the containment evacuation alarm.

2. Source Range Audible Counter (Modes 3, 4, 5 & 6) - An isolated output from the pulse amplifier for the source range instrumentation provides an audible tone proportional to the selected source range channel count rate. The indicated source range neutron flux count is also provided.

3. Flow Differential Alarm (All Modes) - As described in Section 9.3.4.1.3.7, if the boric acid or blended flow rates deviate by more than the preset values, flow deviation alarms are provided to alert the operator.

4. Status Monitoring Instrumentation (All Modes) - Indication of the boric acid and blended acid flow rate and CVCS and RMWS pump status lights is provided (See Section 9.3.4 and Table 7.5-1).

5. Overtemperature ΔT and Rod Insertion Limit Alarms (Modes 1/2) - With the reactor critical and with the reactor in automatic control (Mode 1), the power and temperature increase from a boron dilution event would result in insertion of the RCCAs and a decrease in the shutdown margin. The rod insertion limit alarms (low and low-low settings) would alert the operator to a dilution event. If allowed to proceed, an overtemperature ΔT trip (with alarm) would occur.

   With the reactor in manual control (Modes 1 & 2) and if no operator action is taken, the power and temperature rise from a boron dilution event would cause the reactor to reach the overtemperature ΔT trip setpoint. Power range neutron flux (low and high settings) alarms and trips are also provided.

6. Neutron Flux Shutdown Monitor Alarm (Modes 3, 4, 5, 6) - A qualified, redundant, safety grade neutron flux shutdown monitor is provided to measure the countrate from the qualified class 1E extended range neutron flux monitors (refer to Table 7.5-1). The shutdown monitor provides an alarm when the countrate increases by an amount equal to the alarm ratio that has been set into the shutdown monitor.

   With the above instrumentation, the reactor operator can be alerted to any reduction in shutdown margin.

   This variety of available alarms provides diversity in alerting the operator to a boron dilution event.

   The analysis of the boron dilution event for South Texas takes explicit credit for four alarms. These are, for dilution events during Technical Specification Modes 3, 4, 5, and 6, the Neutron Flux Shutdown Monitor Alarm; for Mode 2 and Mode 1 in manual rod control, the Overtemperature delta-T and power range high nuclear flux reactor trips; and for Mode 1 in automatic rod control, the Low Rod Insertion Limit Alarm.

   The Neutron Flux Shutdown Monitor Alarm is class 1E, protection grade and redundant. The audible alarm is via the QDPS (see Section 7.5.6.2).

The Overtemperature delta-T and power range high nuclear flux reactor trips are part of the Reactor Protection System and are therefore completely safety grade.

The Low Rod Insertion Limit Alarm is control grade. However, it is designed to satisfy NRC General Design Criteria 10, 13, 19, 25 and 26, IEEE standard 279-1971 (Section 4.7, and ANSI standards N18.2-1973, N18.2a-1975, and 18.8-1973.

There is no automatic mitigation system provided for a boron dilution event. The STP Technical Specifications do not currently address the neutron flux shutdown monitors. The technical specifications will be revised after the boron dilution analysis has been completed (1st quarter 1986.)

b. RCS pressure is typically 2250 psia in Modes 1 and 2. Assuming a RCS depressurization contradicts operational procedure and presumes an additional aberration, independent of the occurrence of a boron dilution event. The boron dilution event is defined by SRP 15.4.6 as a Condition II event - an event of moderate frequency. An inadvertent RCS depressurization concurrent with an inadvertent RCS boron dilution is not expected to occur with moderate frequency and would not be considered a Condition II event. Therefore, Modes 1 and 2 do not consider the possibility of a significant RCS depressurization. When the plant is at power, the Tech Specs require pressurizer pressure to be maintained within a certain band to ensure that the DNB design basis is met. There are sufficient conservatisms in the analysis to account for small changes in dilution flowrate caused by small fluctuations in pressure.

Analysis to demonstrate that the South Texas Project meets regulatory requirements regarding boron dilution events is in process. If any administrative changes are necessary to maintain regulatory compliance, these changes will be identified. As part of this effort, a probabilistic analysis will be performed to evaluate the probability of boron dilution events. Plant response to each credible initiator will be modeled to obtain the probability of an uncontrolled boron dilution event resulting in inadvertent criticality. The probabilistic analysis will identify where the South Texas Project is susceptible to boron dilution events, and thus allow Houston Lighting & Power Company to insure that administrative requirements are sufficient to reduce the probability of boron dilution events to an acceptable level.

The analyses for the boron dilution event will be provided in the first quarter of '86.

c. Figure 9.3.4-3 (note 9) identifies the valves in the CVCS system that are locked closed during refueling operations. As can be seen, there is an additional locked closed valve downstream of valve CV0198. ~~The technicale specifications on the locked closed valves are provided in technicale specification Section 3/4.9.~~ Those valves which are specified as locked closed can be found in the Technical Specifications

Question 440.68N

Describe or reference the analytical model used in the BDE calculations. Discuss the degree of conservatism of this model, including that of scram times, moderator and Doppler coefficients, and mixing of coolant.

Response

The solution technique used for the STP boron dilution analysis was developed in support of the Westinghouse flux-doubling detection and automatic boron dilution mitigation system. The method is used to calculate the amount of time from a flux-doubling signal to criticality for an unmitigated boron dilution accident from subcritical modes of operation. For operation at power, the time from reactor trip or rod insertion limit alarm until shutdown margin is lost for a unmitigated BDE is calculated. In compliance with the Standard Review Plan 15.4.6 (Rev. 1 - July 1981) and Reg. Guide 1.70 (Revs. 2 and 3), the solution is utilized to verify that the amount of time necessary for detection and mitigation of the boron dilution accident is less than the amount of time to criticality for an unmitigated event. The technique was presented to the NRC previously and is consistent with the methodology used for plants with the automatic boron dilution protection system.

Additionally, as described in the response to Question 440.67, a probabilistic analysis is being performed to evaluate the probability of boron dilution events from subcritical modes of operation.

The analysis will begin with a detailed Failure Mode and Effects Analysis (FMEA) to identify potential boron dilution initiators. The FMEA will provide a detailed evaluation of the CVCS system to identify potential equipment faults or operator errors which could result in an inadvertent dilution of reactor coolant system boron concentration. Subcritical Modes 3 (hot standby), 4 (hot shutdown), 5 (cold shutdown), and 6 (refueling) will be analyzed.

The frequency of each credible boron dilution event will be calculated using industry accepted equipment failure and human error probabilities. Maximum dilution flow rates for each initiator will be identified. Minimum shutdown boron concentration and shutdown margin, for each mode, will be obtained from the utilities technical specifications. Additionally, minimum reactor coolant system volume will be identified for each mode. Using this information, the time to alarm annunciation of a boron dilution event and time to criticality will be calculated to show compliance with regulatory requirements.

Additionally, a probabilistic analysis of boron dilution events will be performed. Event tree modeling will be employed to calculate the frequency of boron dilution events which result in unplanned criticality. This analysis will include an evaluation of alarm reliabilities, and a probabilistic evaluation of the operator response to the boron dilution event.

FSAR Section 15.4.6 will be revised to reflect the results of the analyses upon completion, first quarter 1986.

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