SAFETY EVALUATION REPORT

Submittal: Letter from A. E. Lundvall, Jr., to R.A. Clark, dated March 23, 1981, and attachment

Subject: Calvert Cliffs Nuclear Power Plant Units 1 and 2, Detection of Boron Dilution Accident

Originating Organization: Baltimore Gas and Electric Company

BACKGROUND

As a part of the submittal for Calvert Cliffs Unit 1 Cycle 5 fuel load application, the licensee presented an analysis of an inadvertent boron dilution event. The calculated time from the initiation of the event until the loss of shutdown margin was 19.7 minutes in the cold shutdown mode and 38.6 minutes in the refueling mode. The licensee also stated that the operator has no positive means of being alerted to a boron dilution event.

The acceptance criteria for a boron dilution event is provided in section SRP 15.4.6, and calls for a minimum time interval of 30 minutes from an alarm to the time a loss of shutdown margin occurs when the plant is in the refueling mode. If the plant is in cold shutdown or any other mode, an interval of 15 minutes is accepted.

In the evaluation of the submittal for the Cycle 5 fuel load application, the staff requested that a positive means be provided to alert the operator and allow him adequate time to terminate a boron dilution event (Reference 1). The licensee agreed to develop a means for such notification during the current cycle for each unit.

EVALUATION

The licensee has proposed an alarm system in which the Wide Range Log Channels (WRLC) of the nuclear instrumentation are monitored by the plant computer. The total number of channels is four and the minimum number required to be operable is two.

Computer availability to date is reported to be better than 98% for both units. With less than the required alarm functions operable, the operator has to monitor WRLC signals at a frequency such that the required time interval for corrective measures is assured. As a backup to WRLC signals, the licensee has identified the plant boronometer which provides the operator with a continuous indication of reactor coolant outlet boron concentration.

The licensee has also proposed Technical Specification changes to increase the time from initiation of the dilution event unitl shutdown margin is lost. These changes apply only to cold shutdown mode with low reactor coolant inventory.

The staff's conclusion of the proposed alarm system is that the main principles are acceptable and the licensee may continue his developing efforts. However, before final conclusion can be reached, the licensee has to provide the staff with additional information and possibly to make some additional changes in Technical Specifications. In the following, are listed the remarks and questions the licensee has to address to make sure that SRP 15.4.6 acceptance criteria are met:

1. The criteria in SRP 15.4.6 do not refer to the time of initiation of a dilution event, but to the time of alarm. In order to determine that the time interval available for corrective measures meets the intervals stated in SRP 15.4.6, additional information on alarm setting and alarm time is needed. To support proposed alarm settings, calculational results which describe the correlation between the neutron

flux and boron dilution have to be presented. Instead of general requirements as proposed in Technical Specifications, table 3.3-1, notation (g) and section 3.9.2, last sentence, more specific alarm settings should be defined. The requirements should be in a form readily understandable to the operator.

2. Calvert Cliffs Unit 1 FSAR, table 9-12, gives a range of measurement of 0-2000 ppm for the boronometer. If this is correct, we do not understand how the boronometer could be used during cold shutdown or refueling as stated in the background section of the submittal letter, since the boron concentration would exceed the measurement range.

   It is the staff's position that the single failure criteria should be met when evaluating the capability to protect against boron dilution events. To meet this criteria, two independent means should be available for detecting and alerting the operator to a boron dilution event during all modes of operation. Alerting means an audible signal.

3. In the proposed Technical Specification change, section 3.9.2, last sentence, an alarm system using the source range neutron flux monitors is mentioned. It is unclear to the staff if that system is the same as the system using WRLC. Please explain.

4. In the proposed Technical Specifications change you have split section 3.1.1.2 in two parts. The second of them, subsection 3.1.1.2.2, to be applied when partially draining the reactor coolant system in the cold shutdown mode, requires that the shutdown margin is increased to 4.3% and two charging pumps are taken out of service. An analysis of this partially drained cold shutdown mode has given a minimum time of 51.7 minutes from the initiation of the dilution event to criticality. However, we do not think it is the most limiting case because:

(1) the active volume of coolant circulating in the reactor pressure vessel and the RHR loop during the cold shutdown mode with the primary circuit filled up is not significantly larger than the active volume in the drained mode, and

(2) the proposed subsection 3.1.1.2.1 of Technical Specifications permits a shutdown margin of only 3.0% and does not limit the number of operable charging pumps.

You should either present an analysis of an event caused by inadvertent operation of all three charging pumps during a normal cold shutdown mode, or consider upgraded limitations to the shutdown margin and to the number of available charging pumps in the normal cold shutdown mode.

5. It is not apparent that the proposed requirements in the Technical Specifications, table 3.3-1, action 5, would be clear to the operator. Neither do the requirements specify how often the operator must monitor the signals. Since the primary method of protection relies upon detection and automatic alarm, the Technical Specifications should restrict the ability of the alarms to be taken out of service during all modes of operation in which manual operator corrective action initiated by alarm is required. Technical Specifications requiring monitoring frequency by the operator should be implemented only where the alarms are taken out of service or otherwise not available. A fixed monitoring frequency based on the minimum calculated dilution time should be provided.

6. In your analyses, you do not take into account the possibility of having continuous flow of unborated water through the standing charging pumps.

- Such flow might be established by the operation of a make-up pump controlling level in the CVCS tank. The capacity of that pump is not given in FSAR. Please discuss the possibility of flow higher than 44 gpm with two charging pumps out of service.

CONCLUSIONS

The staff has found the submittal deficient and is not able to conclude that the plant will be adequately protected against boron dilution events. Specifically, we find the plant does not meet the criteria in SRP 15.4.6.

It is the staff's position that a system be provided to protect against boron dilution events which meets the criteria in SRP 15.4.6. Specifically, this system should:

- o meet the single failure criteria
- o meet the time limits for operator action in SRP 15.4.6 for all modes of operation. This time limit is measured from the time of the first alarm to the time shutdown margin is lost.
- o provide clear, audible alarms to alert the operator
- o be restricted in the ability to take it out of service.

We will consider this issue open until an acceptable response is received from the licensee.

REFERENCES:

1. Memorandum for T.N. Novak, DOL, from Paul S.Check, DSI, on Calvert Cliffs, Unit 1-Cycle 5 Fuel Reload Review, December 2, 1980.