UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

April 21, 1993

NOTE TO: Jack Duncan, GE

FROM: Glenn Kelly, SPSB, DSSA, NRR

SUBJECT: THOUGHTS ON THE ABWR INTERNAL FLOODING ANALYSIS

I have enclosed some thoughts I put together from some comments I received from my contractor on the ABWR internal flooding analysis. I would like to discuss these with you later this week. Please give me a call if you have any questions. Some of the points enclosed are similar to those I faxed to you on March 25, 1993, but for which I have received no written reply.

Enclosure: as stated

<u>ENCLOSURE</u>

Thoughts on the ABWR Internal Flooding Analysis
April 21, 1993

(1) The GE bounding analysis identified the potential flood sources and selected the ones expected to have the greatest impact on the operability of systems required to safely shutdown the plant. No sources were identified that could affect more than one division of equipment without the failure of at least some flood protection features, either isolation barriers or mitigating features. In the review of the flood sources the staff found that at least one flood source, the reactor cooling water surge tanks, was prevented from affecting more than one division through the use of raised sills on the entrance to the room containing the tanks. This is the only feature that prevents this flood source from potentially affecting two divisions of ECCS equipment. Because of the significance of a flood that would affect multiple system divisions, GE should assure that the proper installation of the sills is incorporated into the ITAAC for flood protection. This assurance should be provided by an ITAAC.

(2) The analysis did not address flooding in areas of the design that are the responsibility of the COL applicant, specifically the ultimate heat sink pump house. The COL Action Item 6 of Section 19.9.10 should be revised to include the requirement of a probabilistic assessment of the site specific design features.

(3) The review of the event trees and the quantification of the event trees did result in some identification of issues, the resolution of which would have some affect on the results of the analysis. In the turbine building flood analysis, one of the events taken credit for is the release of flood waters through the turbine building truck entrance door. Because this door is not a watertight door, the analysis models the failure of the door to fail open with a probability of 0.05. However, no justification for this value is provided and the assumption that the door would fail is contrary to normal PRA practices that do not use beneficial failures as possible mitigating measures. The staff requests that GE provide the staff with an assessment of the height of water that could be retained by the truck door before it would be expected to fail and how this height relates to the flood level necessary to allow for flooding in the control building. Alternatively, credit for the failure of the door should be removed from the event tree.

(4) This event tree also takes credit for the protection provided by the watertight door between the turbine building and the control building, failure of the door to stop the flood is assumed to result in the failure of all equipment in the control building. While this is reasonable, it highlights the need to ensure that the watertight door is maintained and inspected properly. In a response to an RAI, GE states that credit was taken because in current operating plants the status of the door is typically visually checked during each shift. Since this

assumption is part of the basis for crediting the watertight door, a COL Action Item is required to ensure that these inspections are incorporated into plant operating procedures.

(5) In the quantification of the control building event tree, there is an event titled "automatic flooding isolation." This event is quantified as representing the failure to isolate the supply side of the service water system. This event consists of a combination of reactor service water system valve, siphon breaker and pump trip failures. However, the conceptual design of the reactor service water system shows only one motor operated valve between the control building and the system discharge. If this valve were to fail and the UHS is at a higher elevation than the basement of the control building, the location of the break, backflow into the building would be possible. This unisolated flood becomes the most dominant flood in all of the three buildings. The NRC is unclear whether additional protection is needed to reduce the likelihood of this unisolated flood. Insufficient information was available to determine if this issue is of concern for the circulating water system and the turbine building service water system. As part of this concern, the susceptibility of these systems to backflow through the discharge lines should be addressed.

(6) In the reactor building flood in the ECCS room event tree there is an event titled "sump level switches detect flood." In the event tree no credit is taken for the operation of the sump pumps and the operator cannot isolate the flood. It is not clear why this event is included in the event tree. Additionally, in this event tree and in the reactor building flooding in corridor, the possibility of flood waters entering all three divisions of ECCS was not considered. Due to the relationship between the conditional core damage probabilities associated with the loss of one, two, and three divisions of ECCS, the sequence containing failure of all three watertight doors and the subsequent failure to safely shutdown the reactor with no ECCS available has a higher frequency of core damage than the sequences containing the failure of one or two ECCS divisions due to the flood. **[this is an insight]**

(7) The reactor building flood event trees consider the failures of the watertight doors protecting the ECCS rooms. Only random failures are considered, common cause failures are not. As part of the review, these two event trees were requantified to address these three concerns. The sequences were modified to reflect the possibility of failure of all three watertight doors and the data of table 19R5.2 was used to address common cause failure of the watertight doors. Only one sequence, when requantified, had a core damage frequency greater than 10^{-8} per year. This sequence, with a frequency of approximately 10^{-7} per year is a flood in the ECCS corridor followed by the common cause failure of all three watertight doors and the failure of the reactor to be safely shutdown with all three divisions of the ECCS unavailable. To be consistent with the GE analysis, this requantification used the 0.1 value for shutdown of the plant (which assumes that the power conversion system is unavailable) rather than the loss of division 1, 2, and 3 power or service water systems. Although the requantification significantly increases the frequency of core damage due to internal floods in the reactor building, there are reasons that this particular

. internal flood becoming a potential vulnerability. This is because of the conservatism of the underlying analysis, the absolute value of the estimated core damage frequency, and the significant uncertainty in the common cause failure value used for the three ECCS doors.