From: Peter Tam
To: David Helker; Douglas Walker
Date: 7/1/05 9:59AM
Subject: Draft RAI for TMI-1 - Response to Bulletin 2003-01 **(TAC MB9620)**

Doug:

Below please find a draft RAI on your response to Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at PWRs." Tim Colburn, former Project Manager, had supposedly faxed the same to you some days ago, but you told me you did not receive the fax.

This draft RAI aims solely to prepare you for a conference call with the NRC staff. It does not formally request for information, nor does it convey a formal NRC staff position.

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TMI-1, BULLETIN 2003-01 SUPPLEMENTAL RAI ON BWST REFILL

Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors," requested that pressurized-water reactor (PWR) licensees that were unable to confirm compliance with regulations pertaining to emergency recirculation sump performance consider adopting interim compensatory measures until compliance could be confirmed.

In response to Bulletin 2003-01, as well as several subsequent Requests for Additional Information (RAIs), the licensee for Three Mile Island (TMI), Unit 1, submitted justification for its position that substantial safety benefit could not be achieved by refilling the Borated Water Storage Tank (BWST) if it became depleted during an accident, which is one of the interim compensatory measures suggested for licensee consideration in the bulletin.

To support its position, the licensee gave several arguments that refilling the BWST is not safety beneficial, which are summarized as follows: (1) refilling the BWST would not substantially delay the switchover to emergency sump recirculation, (2) flow rates for systems that could be used to refill the BWST are relatively small, (3) injecting more than a single BWST volume into containment could flood environmentally qualified (EQ) instrumentation in lower containment, jeopardizing its functionality, (4) boron concentration could be reduced if unborated water is used for refilling the BWST, and (5) the pH of the water in containment could be adversely affected by injecting more than a single BWST volume of emergency coolant.

As explained below in detailed responses to the five arguments summarized above, the NRC staff considers the licensee's rationale to be insufficient justification for not implementing the interim compensatory measure of refilling the BWST upon switchover to recirculation.

First, although the staff agrees that refilling the BWST during the injection phase may not substantially delay the switchover to recirculation for a design-basis large-break loss-of-coolant accident, the staff believes that the pertinence of this fact is limited. In particular, the licensee's discussions have not adequately addressed the potential risk benefit that could be achieved by initiating the refilling of the BWST immediately following the switchover to sump recirculation. For many PWRs and particularly for the most risk-significant accidents requiring sump recirculation, sump clogging would not necessarily be expected to occur immediately upon the switchover to recirculation. Rather, in these circumstances, sump clogging would more likely

come about gradually, as debris is steadily filtered out of the water passing through the sump screen and accumulating as a bed over the screen. Under these conditions, if sump clogging were to occur, it would likely occur after a period (of highly variable and uncertain duration) during which makeup inventory (perhaps quite a significant amount) could be added to the BWST. In WCAP-16204, Revision 1, "Evaluation of Potential ERG and EPG Changes to Address Bulletin 2003-01 Recommendations (PA-SEE-0085)," the Westinghouse Owners Group (WOG) analyzed the potential risk benefit of various interim compensatory measures to prevent or mitigate the possible debris-induced loss of the emergency sump recirculation function. The WOG found that refilling the RWST "is expected to provide a significant positive risk impact," and "generally recommended" this action following the switchover to recirculation. Although the WOG's report specifically analyzed only Westinghouse and Combustion Engineering plants, the staff believes that, as a result of design similarities, similar conclusions would also apply to Babcox & Wilcox (B&W) plants with regard to refilling the BWST. The staff's belief is further supported by the responses of other B&W plants (excepting Davis-Besse, which responded to Bulletin 2003-01 by confirming compliance with existing recirculation sump performance regulations), which have implemented or will implement BWST refilling upon switchover to recirculation as an interim compensatory measure. NRC-sponsored studies and regulatory documents, such as LA-UR-02-7562, "The Impact of Recovery From Debris-Induced Loss of ECCS Recirculation on PWR Core Damage Frequency," and Generic Letter 88-20, Supplement 2, "Accident Management Strategies for Consideration in the Individual Plant Examination Process," have also generally suggested that refilling the BWST following the switchover to recirculation is a viable method for reducing risk that PWR licensees may consider plant-specifically. Based upon the discussion presented above, the staff finds that the licensee has not submitted sufficient justification that refilling the BWST following the switchover to recirculation would not provide substantial benefit to TMI, Unit 1.

Second, although available makeup sources may have relatively small flow rates, given sufficient time, a substantial amount of inventory could be accumulated in the BWST for injection in case sump recirculation were subsequently lost. As noted above, the length of time between the switchover to recirculation and the (potential) loss of emergency sump recirculation is highly variable, being strongly dependent upon such parameters as local and global debris sources and the size and location of the pipe break. Further, very little research and analysis have been performed with regard to the time dynamics of debris blockage effects; thus, large uncertainties exist in this area. As a result of the variability and uncertainty associated with time-dependent debris blockage effects, the staff feels that the licensee's determination that available flow rates are too small to provide significant benefit is unsubstantiated. For example, if sump recirculation functioned for one hour prior to failing due to debris blockage, even with a BWST makeup flow rate on the order of hundreds of gallons per minute, a substantial inventory of injection could be accumulated by initiating refill immediately following switchover, since by this time, necessary core cooling flows would be greatly reduced from the large flow rates required immediately following an accident.

Third, although the flooding and loss of function of EQ instrumentation should obviously be a consideration in determining whether to inject more than one BWST volume of water into containment, the staff does not believe that it provides justification for not initiating the refilling of the BWST following the switchover to recirculation. The intent of refilling the BWST following switchover is to accumulate a supply of emergency coolant so that a licensee may subsequently have the opportunity to decide whether or not to inject this coolant into containment (e.g., in conjunction with emergency procedures or severe accident management guidelines following indications of unrecoverable sump clogging). By initiating BWST refilling immediately following switchover, rather than upon indications of sump clogging, assurance is increased that additional emergency coolant will be available in the case that a licensee determines its use to be appropriate. Furthermore, it should be stressed that, if a beyond design basis event, such as the loss of emergency sump recirculation, were to occur, the need to maintain reactor core cooling could become more urgent than the need to maintain the functionality of EQ instrumentation (the staff notes that the licensee's submittals do not specify precisely which EQ equipment could be flooded). For this reason, the staff feels that the functionality of EQ equipment does not comprise adequate justification for not refilling the

BWST immediately following the switchover to recirculation, nor have the licensee's submittals provided an adequate basis for rejecting categorically the possibility of injecting more than a single BWST volume into containment under such beyond-design-basis conditions as the loss of emergency recirculation cooling to the reactor core.

Fourth, although boron depletion in the reactor vessel is a potential concern, the staff believes this concern would not be significantly exacerbated if the BWST were refilled with a source of borated water. The licensee stated in its submittals that the spent fuel pool could potentially provide a source of borated water. The staff could not determine from the licensee's submittals whether other systems (possibly non-safety-related systems, such as normal makeup or bleed holdup tanks) might also be available to provide borated water to refill the BWST following the switchover to emergency recirculation. If reactor core cooling is lost and borated sources cannot be procured under accident conditions, the use of a limited quantity of unborated water could be risk beneficial in light of the urgency of restoring core cooling. As noted in WCAP-16204, however, a significant drawback to the use of unborated water is that it may involve thoroughly mixing the contents of the BWST to ensure that the unborated water added to the tank does not simply float on the surface of the borated water remaining in the BWST. Thus, the staff finds that the licensee has not provided sufficient justification that the potential risk of a reduced boron concentration in the reactor vessel (in the beyond-design-basis situation of recirculation loss due to sump clogging) forms a substantive basis for not refilling the BWST following the switchover to recirculation.

Fifth, considerations associated with the pH of the containment pool are generally manageable, long-term problems in comparison to imminent core damage. This fact is recognized by WCAP-16204, which states that, if excess water containing boric acid is injected into containment, the additional boric acid "will eventually have to be neutralized" (e.g., with sodium hydroxide or trisodium phosphate). If borax is used as a borating agent, or unborated water is used, however, additional neutralization may not be required. Therefore, the staff does not consider an abnormal pH in the containment pool to form a substantive basis for not refilling the BWST, nor for not injecting additional emergency coolant into the reactor core if necessary to restore core cooling under beyond-design-basis conditions such as the loss of emergency sump recirculation.

In conclusion, without additional information to justify the non-implementation of BWST refilling, the staff cannot confirm that the licensee has fully satisfied the intent of Bulletin 2003-01.

CC: David Solorio; John Lehning; Leon Whitney

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