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0CAN060402

June 10, 2004

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: NRC Bulletin 2003-01 Additional Information
Arkansas Nuclear One – Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6

Dear Sir or Madam:

By letter dated August 7, 2003 (0CAN080302), Entergy provided a 60-day response to NRC Bulletin 2003-01, *Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors.* On April 19, 2004, a telephone conversation was held to discuss requests for additional information (RAIs) regarding the responses for Arkansas Nuclear One (ANO). The responses to the ANO RAIs discussed in the telephone conversation are contained in Attachment 1.

New commitments contained in this submittal are summarized in Attachment 2. Should you have any questions concerning this submittal, please contact Ms. Natalie Mosher at (479) 858-4635.

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 10, 2004.

Sincerely,

Timothy G. Mitchell
Director, Nuclear Safety Assurance

TGM/nbm

Attachments

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cc: Dr. Bruce S. Mallett
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Attachment 1

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NRCB 2003-01 RAI Responses

Bulletin 2003-01 RAI Responses

RAI 1: In your response to Bulletin 2003-01, you state that you will be implementing operator training on indications of and responses to sump clogging. However, your response does not completely discuss the operator training to be implemented. Please provide a detailed discussion of the operating procedures to be modified, the indications of sump clogging that the operators are instructed to monitor, and the response actions the operators are instructed to take in the event of sump clogging and loss of emergency core cooling system (ECCS) recirculation capability.

Please see the responses to RAIs 2 and 3 for a discussion related to the operating procedures.

Response: The operator training conducted at ANO consisted of a computer based training course which included a comprehensive discussion of the issue, a discussion of compensatory measures, symptoms of sump screen blockage, potential water sources (as described in response to RAI 4), and pictures of specific instrument indications (e.g., for ANO-1: reactor building pressure, reactor building sump level, reactor building spray flow, and low-pressure safety injection (LPI) flow, and for ANO-2: high-pressure safety injection (HPSI) pressure, HPSI flow, containment spray pressure, containment spray flow, containment sump level, and containment flood level).

RAI 2: In your response to Bulletin 2003-01, you state that a qualitative risk assessment has been performed, and you determined that procedural modifications that would delay the switchover to containment sump recirculation are not risk beneficial at this time. The NRC staff responses to industry questions and comments on Bulletin 2003-01 (Adams Accession Number ML031810371), Question 37, stated that licensees may use quantitative data to justify not taking an interim compensatory measure. Please provide a description of any risk assessment performed, including qualitative and quantitative insights which justify and demonstrate that implementing this compensatory measure is not beneficial at this time.

Response: The risk assessment performed considered the potential risk negative aspects of procedural modifications that would delay the switchover to containment sump recirculation and compares them to the potential risk positive aspects of procedural modifications that would delay the switchover to containment sump recirculation. The potential risk negative aspects included the increase in the likelihood of operator error and the increase in the likelihood of failure of equipment that is redundant to equipment that experiences a random single failure. The potential risk positive aspects focus primarily on whether the condition intended to be mitigated by the procedural modifications can occur. If it can occur, the potential serious consequences are well known.

In the early minutes following a loss-of-coolant-accident (LOCA), the operators are extremely busy responding to the event in accordance with their emergency operating procedures (EOPs). The EOPs are symptom-based, not event-based. They are used to verify the satisfactory control or restoration of critical safety functions and provide actions to restore and maintain those safety functions when degraded conditions exist. To avoid the risk of taking an incorrect action for an actual event, the EOPs do not prescribe contingency actions until symptoms that warrant those contingency actions are identified. The EOPs are written in such a way that the operator need not diagnose an event in order to establish and maintain a safe plant configuration. To be effective in delaying the switchover to containment sump recirculation, operator actions to stop one train of ECCS must be taken in the first few minutes of the accident. The human failure probability of achieving this action is high given the short action time available. Additionally, this action would introduce a significant opportunity for operator errors based on other actions that are required during this time frame. Any risk benefit achieved by the action would have to offset the additional risk introduced by the additional action during this critical time period. The additional risk introduced is particularly evident for ANO-1 which does not have automatic switchover to the sump and demands focused operator attention to ensure that this critical task is accomplished. At best, the securing of one train of ECCS during a large break LOCA prior to recirculation is considered to be risk neutral. More likely it would lead to an increase in the risk of operator error in performing other critical tasks.

ANO-1 does not have automatic switchover to sump recirculation and thus relies on operator action to make the transition. ANO-2 does have automatic switchover for both trains. If it is assumed that debris will start collecting on the sump screens after switchover to recirculation, and if the quantity of debris available is sufficient, a finite amount of time exists until the screens become clogged enough to impact continued ECCS operation. This amount of time helps determine the probability of successful performance of any operator action to shut down an operating ECCS train. The operator action may be taken based on indication of degradation of the ECCS (operators will be monitoring pump flows and reactor coolant system level) or directed to be accomplished following the switchover to recirculation after confirmation that redundant ECCS trains are in operation. The probability of successfully shutting down an operating ECCS train prior to sump screen clogging would be slightly better if the operator is directed to do so following the switchover, rather than waiting for indication of clogging. However, doing so without an indication of need for it, introduces other risks. For example, the probability of failure to start a pump is increased for a pump that is being restarted without adequate cooldown time after being stopped. Therefore, should a failure occur in the operating train, the redundant train that was shut down would be less likely to be capable of resuming the function of the failed train.

Clearly there is a non-zero increase in risk that would result from procedural modifications that would delay the switchover to containment sump recirculation. This increase is difficult to quantify. However, if there is zero improvement in risk as a result of procedural modifications that would delay the switchover to containment sump recirculation, the net will be an increase in risk. The objective of procedural modifications that would delay the switchover to containment sump recirculation is to partially mitigate, delay or even prevent the risk of debris blocking the sump screen or damaging ECCS equipment. Risk has a consequence component which is multiplied by a probability component. In this case, the consequence component of debris blocking the sump or damaging ECCS equipment is known to be significant. Therefore, this assessment focused on the probability component, more specifically on the existence of the mechanisms necessary to cause significant debris blockage of the sump or damage to ECCS equipment.

Before debris can block the sump or damage ECCS equipment it must be previously existing or generated by the LOCA and, subsequently, transported to the sump. The only mechanism available to cause this movement is recirculation flow. (The ANO-2 sump is not open to the D-ring and is, therefore, not subject to direct deposition of any debris from the LOCA. The ANO-1 sump is open to the D-ring but is completely shielded from both hot legs and three of the four cold legs by structures or equipment. One cold leg has a very limited view of part of the sump so any direct deposition of debris would only occur from a break in a small part of that cold leg and would be extremely limited. The portion of the cold leg in view of the sump has only reflective insulation on it.) Transco, Inc., test data to determine threshold flow velocities for the transport of various forms of debris have more recently been corroborated by tests conducted at the University of New Mexico's Open-Channel Hydrology Laboratory under the auspices of Los Alamos National Laboratory (Maji, Rao, Letellier, Bartlein and Marshall, "Transport Characteristics of Selected Pressurized Water Reactor LOCA-Generated Debris," Nuclear Technology, Volume 139, August 2002). This test data enables a comparison of the possible recirculation flow velocities with the velocities necessary to transport debris to the sump.

Debris within the zone of influence of the break is considered to be generated at the time of the break. ECCS injection will last approximately half of an hour for a large break LOCA during which time debris that has been generated and does not float, will sink to the containment floor. Published settling velocities from the Los Alamos testing for such debris confirm that it will be on the floor by the time the ECCS system is switched over to recirculation. Based upon the Los Alamos testing, once the debris is on the floor, the debris will not resuspend itself into the flow. Floating debris is of no concern since it cannot block the sump screen because the minimum water level is higher than the top of the sump screen. When recirculation is initiated, tumbling velocities must be attained to move any debris across the floor and lift velocities must be attained to lift the debris over any obstructions on the floor such as curbs. These velocities must be created by the ECCS flow toward the sump. Maximum flow on ANO-1 with both trains of LPI and reactor building spray in operation is 10,300 gpm; maximum flow on ANO-2 with both trains of HPSI and containment spray in operation is less than 7000 gpm.

Using the more limiting case of 10,300 gpm, a sump vertically-projected perimeter of 45 ft. and a 5.01 ft. minimum water height above the floor, the average flow velocity at the sump entrance is 0.031 meters/sec (any additional water height above the minimum will result in a lower flow velocity). Since this velocity is less than the limiting published incipient tumbling velocity of 0.037 meters/sec (flume average velocity) for Nukon, thermal wrap, and kawool, no transport of debris to the sump is expected; therefore, no clogging of the sump should occur. Other tested materials, i.e., calcium silicate, paint chips, aluminum and stainless steel reflective metal insulation, and Marinite board, have higher incipient tumbling velocities. Further, the average water velocity across the floor will decrease as the distance from the sump increases. It is recognized that there may be some acceleration of flow around obstacles. If acceleration is significant enough, localized transport of some debris around the obstacle and toward the sump could result, but the flow would decrease after clearing the obstacle and halt continued movement of the debris. Testing confirmed that acceleration of the water did not affect the transport of the debris but that debris transport behaved according to the flow velocity at the current location of the debris. Even if debris were to reach the sump, it would have to be lifted onto the screen to block it. The limiting incipient velocity to lift over a 6 inch curb (Nukon) is 0.085 meters/sec.

This average flume velocity equivalent at the perimeter of the sump is considered to be a value that bounds (on the high side) the slowest velocities that would occur in the flow path of the water from the location of the deposit of the debris on the floor to the sump screen. A more detailed evaluation of potential unevenly distributed flow patterns toward the sump reveals that every path to the sump passes through a location at which the velocity is below the published incipient tumbling velocity in both ANO-1 and ANO-2.

Medium and small break LOCAs demand less ECCS flows, resulting in even lower water velocities across the floor and a lower likelihood of any of the smaller quantity of insulation debris generated by these smaller breaks being transported to the sump.

Therefore, at ANO-1 and ANO-2, debris cannot reach the sump and the risk of debris blocking the sump or damaging ECCS equipment is zero. This leads to a conclusion that there is zero improvement in risk as a result of procedural modifications that would delay the switchover to containment sump recirculation. The net effect of such procedural modifications will be an increase in risk.

As stated in the Technical Letter Report LA-UR-01-4083 prepared for the NRC (August 2001, Revision 1) by Los Alamos National Laboratory, "a firm determination of the vulnerability of any individual plant could require a plant specific evaluation" taking into account various details of the plant's features that were not comprehensively available to the authors of the Technical Letter Report. Although Entergy continues to evaluate this vulnerability in more depth, Entergy's assessment to date of the risk of procedural modifications that would delay the switchover to containment sump recirculation indicates that such modifications are not risk beneficial.

During the telephone conversation on April 19, 2004, the Staff requested that Entergy review LA-UR-04-1227 entitled, *GSI-191: Experimental Studies of Loss-of-Coolant-Accident-Generated Debris Accumulation and Head Loss with Emphasis on the Effects of Calcium Silicate Insulation*. This report does not address transport of debris to the sump, only the manner in which the debris accumulates on the sump screen and the resulting pressure differential across the sump screen after the debris reaches the sump. All of the sump screen approach velocities used in the testing in the report exceed those that would occur at either ANO-1 or ANO-2.

<u>RAI 3</u>: In your response to Bulletin 2003-01 regarding the compensatory action to delay the switchover to containment sump recirculation, you state that ANO's current process for revisions to the EOPs, due to changes in vendor/Owners Group guidelines, is to evaluate and then incorporate (those deemed appropriate) recommendations from the vendor/Owners Group. The Westinghouse Owners Group (WOG) has developed operational guidance in response to Bulletin 2003-01 for Westinghouse and Combustion Engineering type pressurized water reactors. Please provide a discussion of your plans to consider implementing the WOG guidance. Include a discussion of the WOG recommended compensatory measures that have been or will be implemented for your plant, and the evaluations or analyses performed to determine that these compensatory measures are acceptable for your plant. Provide technical justification for those WOG recommended compensatory measures not being implemented by your plant. Also include a detailed discussion of the procedures being modified, the operator training being implemented, and your schedule for implementing these compensatory measures. Does ANO plan to review the WOG guidance to determine if similar compensatory measures could be implemented on ANO-1, which is a Babcock and Wilcox (B&W) design?

<u>Response</u>: New revisions to the B&W Owners Group Emergency Operating Procedures Technical Bases document 74-115-2414, *Generic Emergency Operating Procedure Guidelines* and to CEN-152, *Combustion Engineering Emergency Procedure Guidelines* have recently been received at ANO. These documents will be reviewed by August 15, 2004. As stated in correspondence dated August 7, 2003 (0CAN080302),

ANO's current process for revisions to the EOPs, due to changes in the vendor/Owners Group guidelines, is to evaluate and then incorporate (those deemed appropriate) recommendations from the vendor/Owners Group. Deviations from the guidelines require a site-specific justification.

RAI 4: In your response to Bulletin 2003-01, you state that you will be implementing procedural modifications to ensure that alternate water sources are available to refill the RWST or to otherwise provide inventory to inject into the core and spray into containment. However, your response does not completely discuss the procedural modifications to be implemented. Please provide a detailed description of the operating procedures to be modified, the specific actions the operators are instructed to take, and the guidance to be provided regarding the timing of operator actions to refill the RWST or to otherwise provide inventory to inject into the core and spray into containment.

Response: Only the severe accident management guidelines (SAMGs) for both ANO units were revised to address alternative water sources. No procedures were revised. The following was added to the ANO-1 SAMGs:

Additional water sources which are available, or can be made available, for injection include, but are not limited to:

- Any remaining inventory in the borated water storage tank (BWST) following suction transfer to the reactor building sump
- Transfer of any clean waste receiver tank inventory to the BWST or spent fuel pool
- Batch boric acid and water additions to the BWST
- Offsite sources of borated water delivered to the site and transferred to the BWST

Unborated water may be added to the spent fuel pool from excess condensate storage tank (CST) inventory or by the service water system to provide additional diluted, but still borated, water to the BWST. As a last resort, pure unborated makeup water can be added to the BWST for injection by the low pressure injection pumps.

The following was added to the ANO-2 SAMGs:

Additional borated water sources available for injection by either the HPSI pumps or the charging pumps include:

- Any remaining boric acid makeup tank (BAMT) inventory after the recirculation actuation signal (RAS)
- Refueling water tank (RWT) inventory after RAS
- Transfer of any excess spent fuel pool inventory to the RWT
- Batch additions to the BAMTs

Additionally, the volume control tank can be manually unisolated and its remaining volume could be injected by the charging pumps. Unborated water may be added to the spent fuel pool from any excess CST inventory or by the service water system to provide additional diluted, but still borated, water to the RWT. As a last resort, pure unborated water can be added directly to the suction of the charging pumps or to the RWT for injection by the HPSI pumps.

RAI 5: NRC Bulletin 2003-01 provides possible interim compensatory measures licensees could consider to reduce risks associated with sump clogging. In addition to those compensatory measures listed in Bulletin 2003-01, licensees may also consider implementing unique or plant-specific compensatory measures, as applicable. Please discuss any possible unique or plant-specific compensatory measures you considered for implementation at your plant. Include a basis for rejecting any of these additional measures considered.

Response: The possible compensatory measures that we considered fell into the categories listed in Bulletin 2003-01; therefore, there were no unique or plant-specific compensatory measures additionally considered for ANO.

Attachment 2

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List of Regulatory Commitments

List of Regulatory Commitments

The following table identifies those actions committed to by Entergy in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	TYPE (Check One)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
New revisions to the B&W Owners Group Emergency Operating Procedures Technical Bases document 74-115-2414, *Generic Emergency Operating Procedure Guidelines* and to CEN-152, *Combustion Engineering Emergency Procedure Guidelines* have recently been received at ANO. These documents will be reviewed by August 15, 2004.	X		August 15, 2004