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10 CFR 50.54(f)

RS-04-100

July 15, 2004

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

> Braidwood Station, Units 1 and 2 Facility Operating License Nos. NPF-72 and NPF-77 NRC Docket Nos. STN 50-456 and STN 50-457

> Byron Station, Units 1 and 2 Facility Operating License Nos. NPF-37 and NPF-66 NRC Docket Nos. STN 50-454 and STN 50-455

- Subject: Braidwood Station and Byron Station Response to Request for Additional Information Regarding Bulletin 2003-01
- References: (1) Letter from M. P. Gallagher (Exelon Generation Company, LLC and AmerGen Energy Company, LLC), "Response to NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors," dated August 6, 2003
 - (2) Letter from George F. Dick, Jr. (U. S. NRC) to Christopher M. Crane (Exelon Generation Company, LLC), "Request for Additional Information Regarding Bulletin 2003-01 Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2," dated May 4, 2004
 - Letter from George F. Dick, Jr. (U. S. NRC) to Christopher M. Crane (Exelon Generation Company, LLC), "Correction to the Request for Additional Information Regarding Bulletin 2003-01 Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2," dated July 8, 2004

In Reference 1, Exelon Generation Company, LLC (EGC) and AmerGen Energy Company, LLC provided the response to NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation," for Braidwood Station, Byron Station, and Three Mile Island Station.

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In Reference 2, the NRC requested that EGC provide additional information in order to complete their technical review of this issue for Braidwood and Byron Stations. Reference 3 provided a clarification to question 2 of the request for additional information and extended the required EGC response date to July 16, 2004.

The EGC response to this NRC request for additional information is provided in the attachment to this letter.

Should you have any questions concerning this letter, please contact David J. Chrzanowski at (630) 657-2816.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on

July 15, 2004 Kenneth

Kenneth A. Aingér Manager, Licensing

Attachments: 1. Additional Information Regarding the Response to NRC Bulletin 2003-01 For Braidwood and Byron Stations

2. Regulatory Commitments

Question 1

The Westinghouse Owners Group (WOG) has developed operational guidance in response to Bulletin 2003-01 for Westinghouse and Combustion Engineering type PWR's. For Byron and Braidwood, the licensee's response stated that they will monitor the WOG activities and will consider implementation of any issued guidance. Please provide a discussion of the WOG recommended compensatory measures that have been or will be implemented for the plants. Include a discussion of the evaluations or analyses performed to determine that these compensatory measures are acceptable for Byron and Braidwood, and provide technical justification for those WOG compensatory measures heing implemented. Also include a detailed discussion of the procedures being modified, the operator training being implemented, and the schedule for implementing these compensatory measures.

Response:

EGC has reviewed the operational guidance provided by the Westinghouse Owners Group (WOG) in WCAP-16204, Revision 1, "Evaluation of Potential ERG and EPG Changes to Address NRC Bulletin 2003-01 Recommendations (PA-SEE-0085)." The compensatory measures proposed in this document consist of a number of generic postaccident operator actions intended to avoid or mitigate emergency core cooling sump blockage. These proposed compensatory actions are referred to as candidate operator actions (COAs). The following discussion addresses each of the COAs. A schedule is provided for those actions that will be implemented and justification is given for those actions that will not be implemented.

The EGC implementation plans for the WOG COAs for Braidwood and Byron Stations are summarized in the following table.

COA	Title	Implementation Status For Braidwood and Byron Stations	
1A	Secure one containment spray (CS) pump prior to initiating containment sump recirculation	COA is not being considered for implementation.	
1B	Secure both CS pumps prior to initiating containment sump recirculation	COA is not being considered for implementation.	
2	Manually establish one train of containment sump recirculation prior to automatic actuation	COA is not being considered for implementation.	
3	Terminate one train of the emergency core cooling system after recirculation alignment	COA is not being considered for implementation.	
4	Early termination of one low pressure safety injection.residual heat removal pump prior to recirculation alignment	COA not applicable to Braidwood and Byron Stations.	
5	Refill of refueling water storage tank (RWST)	COA to be implemented at Braidwood and Byron Stations	

COA	Title	Implementation Status For Braidwood and Byron Stations
6	Inject more than one RWST volume from a refilled RWST or by bypassing the RWST	COA to be implemented at Braidwood and Byron Stations
7	Provide more aggressive cooldown and depressurization following a small-break loss of coolant accident (LOCA)	COA to be implemented at Braidwood and Byron Stations
8	Provide guidance on symptoms and identification of containment sump blockage	COA to be implemented at Braidwood and Byron Stations
9	Develop contingency actions in response to: containment sump blockage, loss of suction, and cavitation	COA to be implemented at Braidwood and Byron Stations
10	Early termination of one train of high head injection prior to recirculation alignment	COA not applicable to Braidwood and Byron Stations.
11	Prevent or delay CS for small-break LOCAs in ice condenser plants	COA not applicable to Braidwood and Byron Stations.

Candidate operator actions that will be implemented

COA 5 - Refill of the RWST

EGC concurs with the action to refill the RWST. However, this action will not be taken until the suction source for the emergency core cooling system (ECCS) pumps and the containment spray (CS) pumps has been switched over to the ECCS recirculation sump. A more detailed discussion on this topic can be found in the response to Question 2

COA 6 - Inject more than one RWST volume from a refilled RWST or by bypassing the RWST

The implementation of this action requires evaluating the impact of the higher water level inside the containment on the accident mitigation sequence. This evaluation will be completed by January 31, 2005. If the evaluation demonstrates a higher water level is acceptable, the necessary procedure changes to implement this COA will be completed by June 30, 2005.

COA 7 - Provide more aggressive cooldown and depressurization following a small-break LOCA

The evaluation of this action is included in WCAP-16204, Revision 1, for the Combustion Engineering plants only, since the Westinghouse Emergency Response Guidelines (ERGs) already address maximizing the cooldown rate up to the Technical Specifications limit.

EGC has reviewed the cooldown instructions in the emergency operating procedures (EOPs) and concludes that, although the maximum cooldown rate allowed by the Technical Specifications (100 °F/hr) is referenced, the procedures do not clearly state the intent of maximizing the cooldown rate for a small-break (SB) LOCA.

As such, operator training will emphasize the need to perform a "rapid" cooldown at a rate near 100°F/hr after a SBLOCA. This will minimize break flow by reducing stored energy in the plant. This action will also limit outflow from the RWST so that the residual heat removal system (RHR) entry conditions for shutdown cooling initiation may be reached before the RWST level drops to the ECCS recirculation sump switchover setpoint.

The necessary operator training, and any necessary changes to Braidwood Station, Unit 1 and Unit 2 procedures 1/2BwEP ES-1.2 and Byron Station, Unit 1 and Unit 2 procedures 1/2BEP ES-1.2, "Post LOCA Cooldown and Depressurization," will be completed by January 31, 2005.

COA 8 - Provide guidance on symptoms and identification of containment sump blockage

As part of the response to NRC Bulletin 2003-01, Braidwood Station and Byron Station operators were given additional training that emphasized how to recognize the symptoms of blockage of the ECCS recirculation sump screens and subsequent pump cavitation (i.e., flow reduction, oscillating amps and discharge pressure). The expectation at Braidwood and Byron Stations is to shutdown the affected pump(s).

Indications of pump distress may be early symptoms of screen blockage. If debris begins to accumulate on the screens, it would be important to have early indication of the degradation in sump performance. This would allow operators to take action to prevent an increase in, or even reduce, the extent of blockage. This successful action would allow the pump(s) to continue taking suction from the ECCS recirculation sump.

Braidwood and Byron Stations have instruments that indicate the water level above the containment basement floor elevation (elevation 377'), and the water level within the ECCS recirculation sump. Currently, environmental qualification (EQ) documentation is in place only for the instruments that measure the water level above the containment floor (1/2LT-PC006 and 1/2LT-PC007).

The water level inside the ECCS recirculation sumps is monitored by level switches 1/2LS-0940A and 1/2LS-0941A. These level switches are connected to five indicating lights in the main control room, with each light representing a level above the bottom of the sump. When four lights are lit, it indicates that sump water level is about two feet below the top of the sump, i.e., at the containment floor elevation, 377'. The fifth light indicates a water level above the containment floor elevation.

The combination of containment floor water level and sump water level could be used to diagnose the initial signs of sump screen blockage. For example, constant or increasing water level above the containment floor combined with decreasing water level inside the

sump is an early indication of sump screen blockage. With this additional information, operators can take action to reduce outflow from the sump.

Formal EQ documentation is not available for the ECCS recirculation sump level instruments. Based on the rating parameters given on the vendor drawing, these instruments are expected to provide accurate indication of water level inside the ECCS recirculation sumps after a LOCA.

EGC will perform a formal evaluation to determine if the water level indication from the Braidwood and Byron Stations in-sump instrumentation can be expected to be accurate and reliable in post-accident conditions. This evaluation will be completed by January 31, 2005. If these level switches can be relied on for this application, changes to Braidwood Station and Byron Station procedures that will utilize the input from these instruments will be completed by June 30, 2005.

COA 9 - Develop contingency actions in response to: containment sump blockage, loss of suction, and cavitation

The WOG Sump Blockage Control Room Guideline (SBCRG) will be implemented at Braidwood and Byron Stations. The necessary procedure changes and training for both stations will be completed by June 30, 2005.

Candidate operator actions that will not be implemented

COA 1A - Secure one containment spray (CS) pump prior to initiating containment sump recirculation

EGC does not intend to adopt this COA for the following reasons. As stated in WCAP-16204, Revision 1, securing one CS pump will have virtually no effect on delaying switchover to containment recirculation during a large-break (LB) LOCA. Also, it is expected that securing one CS pump would also have a small effect on the SBLOCA scenarios. This is based on the following.

- 1. A SBLOCA may result in reactor coolant system (RCS) pressures above the shutoff pressure of the RHR pumps.
- 2. A SBLOCA may not result in containment pressure reaching the CS actuation setpoint of 20 psig. CS operation is not credited in the model for RCS breaks sizes less than 1 square foot in equivalent break area.
- 3. With RCS pressure above the shutoff pressure of the RHR pumps and CS not actuated, the centrifugal charging (CV) and safety injection (SI) pumps would be the only pumps taking suction from the RWST. This operating configuration will increase the time to switchover to the ECCS recirculation sump.
- 4. With RCS pressures maintained sufficiently high for a SBLOCA, the resulting CV and SI pumps flow rates to the RCS may be sufficiently low that the RHR entry conditions for shutdown cooling may be reached before the ECCS switchover to the ECCS recirculation sump is initiated.
- 5. Again, with RCS pressure above the shutoff pressure of the RHR pumps and CS not actuated, if the ECCS sump recirculation phase is reached, the flow for the

Attachment

Additional Information Regarding the Response to NRC Bulletin 2003-01 For Braidwood and Byron Stations

CV and SI pumps will be the only required flow from the ECCS recirculation sump. This operating configuration reduces flow to the ECCS recirculation sump.

In addition, a qualitative assessment of Braidwood and Byron Stations indicates that significant blockage of the ECCS recirculation sump screens is unlikely, therefore, revisions to emergency procedures that would negatively affect the overall timing of the accident response sequence could potentially decrease plant nuclear safety. Therefore, EGC does not consider these changes to be justified as a pre-emptive action.

COA 1B - Secure both CS pumps prior to initiating containment sump recirculation

EGC does not intend to adopt this COA for the following reasons. The WOG recommends implementation of this step only for plants with containment fan coolers that can remove 100% of the decay heat load when spray is stopped and for which containment spray is not required for removal of iodine or pH control.

The analysis of record for Braidwood Station and Byron Station credits operation of the CS system for iodine removal and pH control.

The Braidwood Station and Byron Station safety analysis concludes that a percent of fuel rods may experience cladding failure during a LBLOCA assuming the single failure of one train of ECCS. As stated in WCAP 16204 Revision 1, if containment spray must continue for dose considerations, steps stopping all spray cannot be implemented.

COA 2 - Manually establish one train of containment sump recirculation prior to automatic actuation

EGC does not intend to adopt this COA for the following reasons. Significant changes to the existing post-LOCA response in the EOPs would be necessary. In addition, although this step would result in lower flows from the ECCS recirculation sump, taking this action may result in increased debris accumulation at the screens. Debris present in the post-LOCA water will have less time to settle to the containment floor before recirculation flow from the ECCS recirculation sump begins.

EGC does not consider these changes to be justified as a pre-emptive action.

COA 3 - Terminate one train of the emergency core cooling system after recirculation alignment

EGC does not intend to adopt this COA for the following reasons. A qualitative assessment of Braidwood and Byron Stations indicates that significant blockage of the ECCS recirculation sump screens is unlikely, therefore, revisions to emergency procedures that would negatively affect the overall timing of the accident response

sequence could potentially decrease plant nuclear safety. Therefore, EGC does not consider these changes are justified as a pre-emptive action.

COA 4 - Early termination of one RHR pump prior to recirculation alignment

This WOG recommendation is applicable only to Combustion Engineering (CE) plants.

COA 10 - Early termination of one train of HPSI/high head injection prior to recirculation alignment

This action has been evaluated only for Combustion Engineering plants.

COA 11 - Prevent or delay containment spray for small-break LOCAs (<1.0 Inch diameter) in ice condenser plants

This candidate operator action is not applicable to Byron and Braidwood Stations.

Question 2

In response to Bulletin 2003-01, the licensee stated that guidance is given in emergency procedures to address refueling water storage tank (RWST) refill once it has been determined that a complete loss of emergency coolant recirculation capability exists. The intent of Bulletin 2003-01 is for licensees to consider implementing compensatory measures to reduce the risk associated with potentially degraded or nonconforming emergency core cooling systems (ECCS) and containment spray system recirculation functions. As such, the timing of implementing this guidance in the plants' emergency procedures may not be consistent with the intent of the bulletin. Since there may be some time before sump screens plug, for larger break sizes, refilling the RWST upon switchover, or soon thereafter, could provide a ready source of additional makeup inventory should sump recirculation be lost. For smaller break sizes, early initiation of RWST refill, such as prior to sump recirculation, could effectively prolong the time to switchover and possibly increase the opportunity for plant recovery without necessitating switchover, thereby reducing the potential for ECCS recirculation sump blockage. In the August 6, 2003, response, the licensee did not commit to modifying the procedures to include refilling the RWST prior to or upon switchover to ECCS recirculation. Given the uncertainty associated with this issue, and the potential benefits of implementing this compensatory measure, please explain the basis for not including refilling the RWST earlier in the procedures. In addition, please provide a detailed description of how the current emergency operating procedures address a loss of ECCS recirculation capability.

Response:

Basis for not including RWST refill earlier in the procedures

In response to a LOCA, the RHR, CV, and SI pumps automatically start upon receipt of a safety injection signal. These pumps inject to the RCS, taking suction from the RWST.

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Additional Information Regarding the Response to NRC Bulletin 2003-01 For Braidwood and Byron Stations

The CS pumps start automatically when the containment pressure set point is reached and also take suction from the RWST. The switchover to the ECCS recirculation sumps as the suction source to the RHR pumps is initiated when the RWST water level decreases to approximately 47%.

After the ECCS recirculation line-up is established, the RHR pumps combine to inject to the RCS and to supply water to the suction of the CV and SI pumps. The CS pumps continue to take suction from the RWST until the suction source is manually switched over to the ECCS recirculation sumps when the RWST water level decreases to approximately 12%.

The objective of the RWST refill action is to delay switchover to the ECCS recirculation sumps and to replenish the RWST inventory so that it may be used later in the event.

LBLOCA and SBLOCA – CS Actuated

Initiating RWST refill prior to or upon ECCS switchover will not replenish RWST inventory for later use in the event since the CS pumps continue to inject into the containment until the RWST level reaches 12%. Thus, water added to refill the RWST would be injected into the RCS or sprayed into the containment building. Additionally, the impact on the switchover times, RH or CS, will be insignificant since the outflow rate from the RWST is several times larger than the available refill rate.

SBLOCA – CS Not Actuated

The RCS pressure for small-break LOCAs may remain above the RHR pumps shutoff head. The higher RCS pressure will also result in reduced flow rates for the CV and SI pumps. If the CS actuation setpoint has not been reached, the net effect will be a significant reduction in the RWST outflow rate.

Plant operators will be trained (see response to COA 7) to achieve a rapid cooldown rate to minimize the time needed to reach RHR entry conditions. Altering the existing procedural sequence to add RWST refill steps in this time period is not necessary because it is highly probable that the RHR entry conditions for initiating shutdown cooling (i.e., 350 °F and 360 psig) are achieved before the RWST switchover setpoint is reached.

Furthermore, if the RWST switchover setpoint is reached, the high RCS pressure will limit the flow from the sump to the SI and CV pumps. The reduced flow rate from the sump will result in a reduced debris quantity reaching the sump screens. Combined with the smaller debris quantity that would be generated in a SBLOCA scenario, the overall risk of sump screen blockage is minimal.

Consequently, as recommended by the WOG, Braidwood and Byron Stations will add guidance for initiating refill of the RWST after recirculation alignment has been established for the ECCS and CS pumps. The specific procedure changes and required training will be completed by June 30, 2005. In addition, specific guidance on sources of make-up water for RWST refill will be provided to the Technical Support Center (TSC) personnel. This guidance document will be completed by June 30, 2005.

Detailed description of response to loss of ECCS Recirculation capability in current EOPs

Blockage of the ECCS recirculation sump screens will result in degraded net positive suction head (NPSH) margins for the RHR pumps and the CS pumps. Degraded NPSH values below the required NPSH will result in pump cavitation.

Plant operators are trained to recognize symptoms of pump cavitation (i.e., flow reduction, oscillating amps and discharge pressure) as part of the basic operator training program. Motor current, discharge pressure and flow indications for the ECCS pumps and motor current and flow indications for the CS pumps are available in the main control room. Plant operators are trained to respond to a pump that is experiencing cavitation by shutting down the pump. This action prevents damage to the pump.

If the pumps taking suction from the ECCS recirculation sumps are shutdown, the emergency recirculation capability is lost. In this case, plant operators would enter procedures 1/2BwCA-1.1, "Loss of Emergency Coolant Recirculation," for Braidwood Station and 1/2BCA-1.1, "Loss of Emergency Coolant Recirculation," for Byron Station.

Since the sump screens at Braidwood and Byron Stations would not be fully submerged during a LOCA, the time period most susceptible to sump screen blockage would be the time of minimum containment flood level after the RHR pumps suction has been switched to the emergency recirculation sumps. Consequently, the CS pumps are expected to have their suction source lined up to the RWST and, depending on the timing of the loss of recirculation, the SI and CV pumps may also still be taking suction from the RWST.

The first step of these procedures verifies that at least one train of ECCS is available or restored. If not, then actions are required to restore at least one train of ECCS. SI and RWST swap-over are reset and actions are initiated to add makeup to the RWST. Steam generator level is then verified to ensure an adequate heat sink and a cooldown to 200°F is initiated to reduce break flow.

Containment pressure will be checked and compared to the required reactor containment fan cooler/CS pump combination. If conditions allow, one or both CS pumps will be secured. This considerably reduces flow demand on the RWST. If one CS pump is running, the steps in the procedure direct alignment to the ECCS recirculation sump, provided adequate inventory exists in the sump. The reduction and/or elimination of CS flow are beneficial in reducing flow through the ECCS recirculation sumps. A check is then made to see if the ECCS is in operation. The procedure then directs the operator to start or stop pumps as necessary to establish one train of ECCS. This aids in reducing flow to the ECCS recirculation sump.

If RCS subcooling is not acceptable, which is the expected condition after a LBLOCA, the procedure directs the operator to determine minimum ECCS flow required to remove decay heat. The ECCS flow value is determined from Braidwood Station figures 1/2BwCA-1.1-1 and Byron Station figures 1/2BCA-1.1-1, "Required ECCS Flow vs Time from Trip."

Subsequent steps verify that RCS make up flow is adequate and also provide instructions to adjust the flow, as needed to stabilize or decrease, based on the temperature readings of the ten highest core exit thermocouples. The procedure then directs RCS cooldown and depressurization to establish conditions for placing RHR in service.

The minimum ECCS flow from the RWST can be maintained until the 7% RWST level is reached. At this point, all pumps taking suction from the RWST are shutdown. If the recirculation capability is not yet restored, the procedure directs to add make-up to the RCS from the RCS makeup system.

Braidwood Station procedures 1/2BwCA-1.1 and Byron Station procedures 1/2BCA-1.1 include a continuous action to restore emergency coolant recirculation capability. When one train of ECCS is restored, operators are instructed to return to the procedure and step in effect.

In addition to the current procedure, and as stated above in response to COA 9, Braidwood and Byron Stations will implement the Sump Blockage Control Room Guidelines that have been published by the WOG to minimize the consequences of sump blockage.

Question 3

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 that were considered for implementation at Byron and Braidwood. Include a basis for rejecting any of these additional measures considered.

Response

EGC has reviewed Braidwood and Byron Stations for compensatory measures not already considered under the above listed COAs and have not identified any unique or plant specific actions for implementation.

Attachment 2 Summary of EGC Commitments Braidwood and Byron Stations, Units 1 and 2

The following table identifies commitments made in this document by EGC.

Commitment	Date
Braidwood Station will complete the review of the impact of more than	January 31, 2005
one RWST volume inside containment.	
If more than one RWST volume inside containment does not have a	
negative impact, Braidwood Station will modify the necessary procedures	June 30, 2005
to permit injecting more than one RWST.	
Braidwood Station will provide the necessary operator training, and any	January 31, 2005
necessary changes to Braidwood Station, Unit 1 and Unit 2 procedures	
1/2BwEP ES-1.2 to emphasize a rapid cooldown during a SBLOCA.	
Braidwood Station will perform an evaluation to determine if instruments	· · · · · · · · · · · · · · · · · · ·
1/2LS-0940A and 1/2LS-0941A can provide reliable, post-accident,	January 31, 2005
indication of sump level.	
If sump level instrumentation proves to be reliable, post-accident,	
Braidwood Station will revise the necessary procedures to implement the	June 30, 2005
Sump level input.	lune 20, 2005
Braidwood Station will implement the WOG Sump Blockage Guideline.	June 30, 2005
initiating PWST refill after alignment to recirculation	June 30, 2005
Braidwood Station will provide specific guidance to the Technical	lupo 30, 2005
Support Center personnel on sources of make-up water for RWST refill	Julie 30, 2003
Byron Station will complete the review of the impact of more than one	January 31, 2005
RWST volume inside containment.	banaary 61, 2000
If more than one RWST volume inside containment does not have a	
negative impact. Byron Station will modify the necessary procedures to	June 30, 2005
permit injecting more than one RWST.	· · · · · ·
Byron Station will provide the necessary operator training, and any	January 31, 2005
necessary changes to Byron Station, Unit 1 and Unit 2 procedures	-
1/2BEP ES-1.2 to emphasize a rapid cooldown during a SBLOCA.	
Byron Station will perform an evaluation to determine if instruments	
1/2LS-0940A and 1/2LS-0941A can provide reliable, post-accident,	January 31, 2005
indication of sump level.	
If sump level instrumentation proves to be reliable, post-accident, Byron	
Station will revise the necessary procedures to implement the sump level	June 30, 2005
input.	
Byron Station will implement the WOG Sump Blockage Guideline.	June 30, 2005
Byron Station will modify procedures and provide training for initiating	June 30, 2005
RWST retill after alignment to recirculation.	
Byron Station will provide specific guidance to the Technical Support	June 30, 2005
Center personnel on sources of make-up water for RWST refill.	

(Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)