Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

www.exeloncorp.com

Exelon Nuclear

RS-03-054

March 20, 2003

United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 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: Response to Request for Additional Information Related to NRC Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions"

References:

(1) Letter from G. F. Dick (NRC) to O. D. Kingsley (Commonwealth Edison Company), "Request for Additional Information Related to Generic Letter 96-06; Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2," dated July 28, 2000

(2) Letter from R. M. Krich (Commonwealth Edison Company) to NRC, "Response to Request for Additional Information Related to NRC Generic Letter 96-06, 'Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions,'" dated November 6, 2000

(3) Letter from John N. Hannon, (NRC) to Vaughn Wagoner (Chairman, EPRI Waterhammer Project Utility Advisory Group), "NRC Acceptance of EPRI Report TR-113594, 'Resolution of Generic Letter 96-06 Waterhammer Issues,' Volumes 1 and 2," dated April 3, 2002

The NRC issued Generic Letter (GL) 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," dated September 30, 1996, and requested that licensees evaluate water hammer and two-phase flow concerns associated with containment air cooler cooling water systems. Commonwealth Edison Company (ComEd), now Exelon Generation Company, LLC (EGC), provided the initial response to the GL in letters dated October 28, 1996, January 28, 1997, and May 2, 1997. The NRC subsequently issued

requests for additional information (RAIs) in letters dated April 13 and May 1, 1998. ComEd provided responses to the April 13, 1998, RAI in letters dated June 30 and September 30, 1998; and responses to the May 1, 1998, RAI in letters dated August 27, 1998, February 26 and October 27, 1999.

In addition to this information, in Reference 1, the NRC requested that supplementary information be provided to validate the use of the RELAP5 computer code for evaluating the water hammer and two-phase flow issues discussed in the GL. ComEd provided the requested information in Reference 2. In a follow-up teleconference between members of the NRC and EGC staff, the NRC again expressed concern regarding the use of the RELAP5 computer code for this application. The NRC concurred that the RELAP5 computer code was appropriate for analyzing the voiding phenomenon, however, requested that EGC use the methodology described in the Electric Power Research Institute (EPRI) Report TR-113594, "Resolution of Generic Letter 96-06 Waterhammer Issues," Volumes 1 and 2, dated December 2000, to address the "column closure" phenomenon associated with water hammer. Specifically, the NRC requested that we submit information discussed in Section 3.3, "Licensee Responses to GL 96-06," of the NRC evaluation that approved the methodology used in EPRI Report TR-113594 (i.e., Reference 3). Attachment 1 to this letter provides this information.

Should you have any questions regarding this matter, please contact Mr. J. A. Bauer at (630) 657-2801.

Respectfully,

Kenneth A. Ainger for

Keith R. Jury
Director - Licensing
Mid-west Regional Operating Group

Attachment 1: Response to Request for Additional Information Related to Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions"

Attachment 1

Braidwood Station, Units 1 and 2
Byron Station, Units 1 and 2

Response to Request for Additional Information Related to Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions"

The NRC previously evaluated and accepted the methodology described in Electric Power Research Institute (EPRI) Report TR-113594, "Resolution of Generic Letter 96-06 Waterhammer Issues," Volumes 1 and 2, dated December 2000, to address the water hammer issues discussed in GL 96-06. NRC acceptance of this report is documented in a letter from John N. Hannon, (NRC) to Vaughn Wagoner (Chairman, EPRI Waterhammer Project Utility Advisory Group), "NRC Acceptance of EPRI Report TR-113594, 'Resolution of Generic Letter 96-06 Waterhammer Issues,' Volumes 1 and 2," dated April 3, 2002.

The NRC requested that Braidwood and Byron Stations provide the additional information that is discussed in Section 3.3, "Licensee Responses to GL 96-06," of the NRC evaluation. This information is provided below.

NRC Information Request No. 1

Certify that the EPRI methodology, including clarifications, was properly applied, and that plant-specific risk considerations are consistent with the risk perspective that was provided in the EPRI letter dated February 1, 2002. If the uncushioned velocity and pressure are more than 40 percent greater than the cushioned values, also certify that the pipe failure probability assumption remains bounding. Any questions that were asked previously by the staff with respect to the GL 96-06 waterhammer issue should be disregarded.

Response

EGC certifies that the EPRI methodology was applied to perform the evaluation of potential water hammer loads during a Loss of Coolant Accident (LOCA)/Loss of Offsite Power (LOOP) analysis.

The EPRI methodology, as documented in Technical Report and User's Manual "Generic Letter 96-06 Waterhammer Issues," EPRI # 1006456 and the supporting document "Generic Letter 96-06 Waterhammer Issues - Technical Basis Report, EPRI # 1003098, was utilized to perform the evaluation of potential water hammer loads during a LOCA/LOOP scenario. The methodology was used to characterize a column closure event at the entrance to the Reactor Containment Fan Cooler (RCFC) coils, the most likely location for a void closure event based on a review of the geometry. This was consistent with the results of RELAP5 modeling previously performed on the RCFC Essential Service Water (SX) System piping. The uncushioned velocity was found to be 20% greater than the cushioned velocity, well within the 40% value suggested above. The forces were developed for both the cushioned and uncushioned cases and shown to be substantially less than those developed in the earlier RELAP5 Mod 3.1.1. The conclusion drawn from the EPRI methodology calculation was that the previous structural analysis, based on RELAP5 generated dynamic loads, was conservative as performed.

A letter from V. Wagoner (EPRI) to J. Tatum (NRC), "Response to ACRS Comments (letter dated 10/23/01) on the EPRI Report on Resolution of NRC GL96-06 Waterhammer Issues," dated February 1, 2002, provided a probabilistic evaluation for the combined event of LOCA, LOOP, and subsequent failure of RCFC cooling water supply lines. A review of the probabilities assigned to the LOCA and LOOP by EPRI was conducted by EGC. We concluded that the EPRI assumed values are reasonable representations of Byron and Braidwood Stations. As described above, we have determined that the cushioned and uncushioned velocities are well within the 40% values suggested, supporting that the pipe failure probability is also bounded.

NRC Information Request No. 2

Provide the additional information that was requested in RAIs that were issued by the NRC staff with respect to the GL 96-06 two-phase flow issue (as applicable).

Response

All additional information requested by the NRC related to the two-phase flow issue was provided in a previous letter from R. M. Krich (Exelon Generation Company, LLC) to the NRC, "Response to Request for Additional Information Related to NRC Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," dated November 6, 2000. A summary of the two-phase flow evaluation results is also presented below in the response to information request No. 3.

NRC Information Request No. 3

Provide a brief summary of the results and conclusions that were reached with respect to the waterhammer and two-phase flow issues, including problems that were identified along with corrective actions that were taken. If corrective actions are planned but have not been completed, confirm that the affected systems remain operable and provide the schedule for completing any remaining corrective actions.

Response

The analysis performed for the Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2 provided conservative evaluations of water hammer and two-phase flow conditions in the SX system during a postulated LOCA/LOOP scenario. Due to the geometry of the cooling water system, void generation will only result from steam generation in the coils. The analysis model was developed to maximize the heat transfer to the coils and therefore the amount of void generation. This leads to creation of a void in the supply header that is susceptible to rapid collapse and closure subsequent to SX pump restart and reflood of the system. Use of the EPRI methodology for this situation yielded pressures in the range of 100 psig (uncushioned), as compared to the approximately 120 psig predicted by RELAP5. A comparison of the integrated forces from the EPRI predictions versus the RELAP predictions shows that the RELAP5 loads were considerably larger. This is in large part due to the deliberate conservative selection of boundary condition pressures in the RELAP5 model, since both RELAP and EPRI comparisons were based on the same voiding fractions. The analysis of the structures demonstrated that the structures were able to sustain the hydrodynamic loadings, without requiring additional supports or other modifications. No operator actions or procedural changes were necessary as a result of this issue.

The two phase flow evaluation demonstrated that the RCFCs would be expected to refill and resume normal subcooled liquid flow through the coils rapidly after the SX pump restart. Cases were analyzed with limiting low pressure boundary conditions to demonstrate that refill and restoration of single phase flow through the RCFC coils would occur, even if conditions favorable to continued void generation were postulated. These cases showed rapid restoration of single phase flow at design values, as well. Therefore, the thermal performance of the RCFCs would not be degraded and the design heat removal assumed in the containment analyses is assured.

Therefore, with respect to the water hammer and two-phase flow issues, EGC has concluded that no corrective actions were necessary and the affected systems remain operable.