Commonwealth Edison Company
1400 Opus Place
Downers Grove, IL 60515

October 13, 1995

ComEd

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Document Control Desk

Subject: Response to Request for Additional Information Regarding
GL 95-03,"Circumferential Cracking of Steam Generator Tubes"
Byron Station Units 1 and 2
Braidwood Station Units 1 and 2
NRC Docket Numbers:50-454, and 50-455
NRC Docket Numbers: 50-456 and 50-457

References:
1. G. Dick letter to D. Farrar dated September 13, 1995, transmitting Request for Additional Information Regarding Circumferential Cracking of Steam Generator Tubes for Byron and Braidwood Units 1 and 2

2. M. Vonk letter to Nuclear Regulatory Commission dated June 27, 1995, transmitting Response to GL 95-03

3. USNRC GL 95-03, "Circumferential Cracking of Steam Generator Tubes"

In Reference 3, the Nuclear Regulatory Commission transmitted GL 95-03, "Circumferential Cracking of Steam Generator Tubes". Reference 2 documented Commonwealth Edison's (ComEd) response to the Generic Letter for Byron, Braidwood and Zion Nuclear Power Stations. As a result of the Staff's review of this response, a Request for Additional Information (RAI) was transmitted for Byron and Braidwood Units 1 and 2 via Reference 1. Attachment A is ComEd's response to the RAI for Braidwood and Byron Unit 1. Attachment B contains ComEd's response to the RAI for Braidwood and Byron Unit 2.

Please address any questions concerning this correspondence to this office.

Sincerely,

Denise M. Saccomando
Senior Nuclear Licensing Administrator

Attachment
cc: R. Assa, Braidwood Project Manager-NRR
G. Dick, Byron Project Manager-NRR
S. Ray, Senior Resident Inspector-Braidwood
H. Peterson, Senior Resident Inspector-Byron
H. Miller, Regional Administrator-RIII
Office of Nuclear Safety-IDNS

A001
1/1

ATTACHMENT A

Response to NRC Request for Additional Information
Regarding Circumferential Cracking of Steam Generator Tubes
Byron Station Unit 1 and Braidwood Unit 1
Docket Numbers STN 50-454 and STN 50-456

NRC Letter Dated September 13, 1995

The following are responses to the request for additional information regarding circumferential cracking of steam generator tubes for Byron Station Unit 1 and Braidwood Station Unit 1. Question numbering is keyed to that used by the NRC in the transmittal of the RAI to ComEd.

---

1. It was stated that the largest circumferential crack identified during the Byron, Unit 1, inspection was removed from the steam generator. Clarify whether or not this was the largest indication identified during the field examination or subsequent analysis determined that this was the largest indication. If subsequent analysis determined it to be the largest indication, were all the data systematically reviewed with the same criteria?

   RESPONSE

   The tube that was removed from the steam generator during the Byron Unit 1 Cycle 6 inspection was the largest circumferential crack based on field examination results. Subsequent re-analysis was performed on the five largest field examination circumferential cracks to confirm that the tube removed was the most limiting tube in terms of structural integrity. This re-analysis confirmed that the tube removed was the most limiting tube for structural integrity and burst pressure. The re-analysis criteria was identical for all five tubes and was more stringent than the field examination criteria.

2. Several plants with preheater model steam generators expanded tubes into the tube support plate in the preheater region to minimize the potential for vibration induced wear. Since these expansions contain similarities to other expanded regions which have experienced circumferential cracking, discuss whether or not this area is susceptible to circumferential cracking. If this area is susceptible to circumferential cracking, please submit the information requested in Generic Letter (GL) 95-03 per the guidance contained in the GL.

   RESPONSE

   Byron Unit 1 and Braidwood Unit 1 steam generators contain approximately 132 cold leg preheater tubes in each steam generator that were hydraulically expanded at 2 baffle plates to mitigate flow induced vibration. Susceptibility to circumferential cracking is a function of stress, temperature, and operating time. The stresses induced due to the hydraulic expansion process are significantly lower than the stresses associated with a hard roll process. Corrosion tests of hydraulic tubesheet

expansions in highly caustic environments have shown that corrosion has been arrested at a temperature of 557 °F, while increasing corrosion rates were found at temperatures of 575 °F to 595 °F. The preheater expansions at Byron Unit 1 and Braidwood Unit 1 are located in areas with a primary side temperature of approximately 550 °F. This is below the temperature where corrosion has been arrested in corrosion tests, which further reduces the likelihood of developing circumferential cracking.

Although the susceptibility to circumferential cracking at the preheater expansions is considered to be low for the reasons discussed above, ComEd will implement an inspection program to detect circumferential cracking. A 20% sample of the preheater tube expansions in one steam generator will be inspected with an EPRI Appendix H qualified method (primarily 3-coil rotating pancake coil (RPC)). Should circumferential cracking be found, all preheater tube expansions will be inspected in all four steam generators. All personnel performing the eddy current data analysis will be certified to the EPRI Appendix G Qualified Data Analysis (QDA) guidelines. RPC inspection of the preheater expansions has not been previously performed at either unit.

In the unlikely event that primary-to-secondary leakage should occur, Byron Unit 1 and Braidwood Unit 1 have lowered the Technical Specification primary-to-secondary leakage limits to 150 gpd. This specification requires the unit to be shutdown if this limit is reached. Additionally, an administrative limit requires the unit to be shutdown if primary-to-secondary leakage increases by 25 gpd in one hour for leakage greater than 50 gpd.

Due to the short operating period to the next Byron Unit 1 inspection (scheduled for October 20, 1995) and with the lowered leakage limits, continued operation is justified. Byron Unit 1 will implement the preheater expansion inspection program during this inspection.

Braidwood Unit 1 shutdown for refueling and steam generator inspections on September 29, 1995, and will implement the described preheater expansion inspection program during this inspection.

ATTACHMENT B

Response to NRC Request for Additional Information
Regarding Circumferential Cracking of Steam Generator Tubes
Byron Station Unit 2 and Braidwood Unit 2
Docket Numbers STN 50-455 and 50-457

NRC Letter Dated September 13, 1995

The following are responses to the request for additional information regarding circumferential cracking of steam generator tubes for Byron Station Unit 2 and Braidwood Station Unit 2. Question numbering is keyed to that used by the NRC in the transmittal of the RAI to ComEd.

---

1. In your response, it was indicated that dented locations (specifically dented support plate locations) are susceptible to circumferential cracking and that plans are in place for detecting circumferential cracking at dented tube support plates (TSP) if it develops. Specify the inspections performed (scope and probe) during the previous Byron Unit 2 and Braidwood Unit 2 steam generator tube inspection outages.

   It was indicated that dents greater than 5.0 volts will be inspected with an Appendix H qualified probe. Provide the procedures used for sizing dents. If the procedure is identical to the procedure for the voltage-based repair criteria, a detailed description is not necessary.

   Future inspection plans for dented (> 5 volts) intersections concentrate at the lowest hot-leg TSPs. A large dent at an upper TSP may be more significant in terms of corrosion susceptibility as a result of higher stresses than a small dent at a lower TSP even though the temperature is lower at the upper TSP. Given this, discuss the basis for the proposed sample strategy given that cracking depends on many factors including temperature and stress levels.

   Clarify if the 20 percent sample of dents will be determined from the number of dents greater than 5.0 volts at all TSPs or from the number of dents greater than 5.0 volts at the lowest hot leg TSP.

   RESPONSE
   The June 27, 1995, ComEd response indicated that inspection plans are in place at all ComEd units to detect circumferential cracking at dented support plate regions. For Byron Unit 1 and Braidwood Unit 1, the inspection plans were implemented in previous inspections in accordance with the voltage-based repair criteria (IPC) requirements. Inspections specifically focused at dented tube support plates have not yet taken place in either Byron Unit 2 and/or Braidwood Unit 2 steam generators. Previous inspections at Byron Unit 2 and Braidwood Unit 2 were typically performed with standard 0.610 inch diameter bobbin probes on 100% of the hot leg tubes and approximately 50% of the cold leg tubes. The bobbin probe is not sensitive to detecting circumferential cracks. No defect indications were reported at any dented tube support plate with the bobbin coil probe. Dented tube support plates were not RPC inspected. Plans are in place to implement a program for detecting circumferential cracking at dented tube support plates for the next inspection at Byron Unit 2 and Braidwood Unit 2.

Byron Unit 2 and Braidwood Unit 2 will implement the IPC methods and procedures that apply to the Unit 1 steam generators for detection and sizing of dented tube support plates.

ComEd has revised the inspection scope for dented tube support plates from the June 27, 1995, response. The revised scope is as follows:

- A 20% sample of all hot leg tube support plate intersections that contain dents greater than 5.0 volts will be inspected by an eddy current technique that is sensitive to both axial and circumferential indications. The initial sample is based on the total population of hot leg dents greater than 5.0 volts at tube support plates in the steam generators selected for inspection and focuses on the largest amplitude dents. All personnel performing the eddy current data analysis will be certified to the EPRI Appendix G Qualified Data Analysis (QDA) guidelines.

- If a circumferential indication is found in the initial 20% sample, then all dents at hot leg and cold leg tube support plates greater than 5.0 volts will be inspected in all steam generators by the same technique as the initial inspection.

Byron Unit 2 and Braidwood Unit 2 contain Westinghouse Model D-5 steam generators. These generators contain thermally treated Inconel 600 tubing with stainless steel quatrefoil tube support plates. Corrosion induced denting is eliminated with the stainless steel quatrefoil support plate design. Therefore, the only dents of concern are those that occurred during manufacturing., and any new mechanically induced denting. The thermally treated tubing greatly reduces the susceptibility to cracking at the dented tube support plates. Consequently, the sample program described above will adequately monitor for degradation of dented tube support plates.

2. Several plants with preheater model steam generators expanded tubes into the tube support plate in the preheater region to minimize the potential for vibration induced wear. Since these expansions contain similarities to other expanded regions which have experienced circumferential cracking, discuss whether or not this area is susceptible to circumferential cracking. If this area is susceptible to circumferential cracking, please submit the information requested in Generic Letter (GL) 95-03 per the guidance contained in the GL.

RESPONSE

Byron Unit 2 and Braidwood Unit 2 contain approximately 132 cold leg preheater tubes per steam generator that were hydraulically expanded at 2 baffles plates to mitigate flow induced vibration. Susceptibility to circumferential cracking is a function of stresses, temperature, and operating time. The Byron Unit 2 and Braidwood Unit 2 steam generators are Westinghouse Model D-5s. These contain thermally treated Inconel 600 tubing and hydraulically expanded tubesheets. Hydraulic expansions have significantly lower stresses than hard roll expansions. The thermally treated tubing also significantly reduces the susceptibility of circumferential cracking. The preheater expansions at Byron Unit 2 and Braidwood Unit 2 are located in areas with a primary side temperature of approximately 550 °F. This is below the temperature where corrosion has been arrested in corrosion tests, which further reduces the likelihood of developing circumferential cracking.

A 20% top of hot leg tubesheet RPC inspection in one steam generator has previously been performed at Byron Unit 2. At Braidwood Unit 2, a 10% top of hot leg tubesheet RPC inspection was performed in 2 of the 4 steam generators. No detectable indications of corrosion was found at either site. ComEd believes that if the Byron and Braidwood Unit 2 steam generator hydraulic expansions are susceptible to circumferential cracking it would first occur at the hot leg tubesheet transitions.

Although the susceptibility to circumferential cracking at the preheater expansions are considered to be low for reasons discussed above, ComEd will implement an inspection program to detect circumferential cracking at the next Byron Unit 2 and Braidwood Unit 2 inspections. A 20% sample of the preheater tube expansions in one steam generator will be inspected with an EPRI Appendix H qualified method (primarily 3-coil rotating pancake coil (RPC)). Should circumferential cracking be found, all preheater tube expansions will be inspected in all four steam generators. All personnel performing the eddy current data analysis will be certified to the EPRI Appendix G Qualified Data Analysis (QDA) guidelines. RPC inspection of the preheater expansions have not been previously performed at either unit.

In the unlikely event that primary-to-secondary leakage should occur, Byron Unit 2 and Braidwood Unit 2 have lowered the Technical Specification primary-to-secondary leakage limits to 150 gpd. This specification requires the unit to be shutdown if this limit is reached. Additionally, an administrative limit requires the unit to be shutdown if primary-to-secondary leakage increases by 25 gpd in one hour for leakage above 50 gpd.

Due to the low susceptibility of thermally treated hydraulic expansions at cold leg temperatures and the lowered leakage limits, continued operation is justified. The above inspection program will be conducted during the next Byron Unit 2 and Braidwood Unit 2 refueling outages, scheduled to be September 6, 1995, and March 2, 1996, respectively.