November 7, 2000

Mr. Oliver D. Kingsley, President
Nuclear Generation Group
Commonwealth Edison Company
Executive Towers West III
1400 Opus Place, Suite 500
Downers Grove, IL 60515

SUBJECT: QUAD CITIES, UNIT 1 - APPROVAL OF WELD OVERLAY REPAIR DEFERRALS (TAC NO. MB0312)

Dear Mr. Kingsley:

By letters dated October 24 and October 25, 2000, as supplemented by letter dated October 27, 2000, Commonwealth Edison Company (ComEd, or the licensee) informed the NRC of changes in the remediation plan for welds susceptible to intergranular stress corrosion cracking at Quad Cities Nuclear Power Station, Unit 1 (QC1), and requested NRC approval of a pipe flaw evaluation and partial weld overlay repair for a weld in the QC1 reactor recirculation piping. The approval was requested in accordance with Generic Letter (GL) 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," dated January 25, 1988.

Due to unexpectedly high primary system dose rates during the current refueling outage, personnel exposures are significantly higher than planned for repairs on the reactor recirculation piping. This has lead ComEd to re-evaluate its plans for weld overlays on three welds. ComEd has proposed that QC1 can operate safely with deferred overlay repairs on welds 02AS-S4 and 02AD-F12, and with a partial weld overlay on weld 02BS-F4.

The staff has reviewed the information provided by the licensee, as well as information provided by teleconference on October 30, 2000, as described in the enclosed safety evaluation, and concludes that the licensee's proposal is acceptable. In order to support the refueling outage schedule, on November 1, 2000, the staff provided the licensee with verbal approval of their request. This letter provides the follow-up documentation of the verbal approval.

The staff requests that the licensee inform the staff, within 90 days of the date of this letter, of its plans to (1) reexamine and complete the weld overlay of the 02BS-F4 weld during the next availability (next refueling outage or other extended outage of sufficient duration), and (2) inspect and repair welds 02AS-S4 and 02AD-F12.

If you have any questions regarding this matter, please call me at (301) 415-1321.

Sincerely,

/RA/

Stewart N. Bailey, Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-254

Enclosure: Safety Evaluation

cc w/encl: See next page

If you have any questions regarding this matter, please call me at (301) 415-1321.

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/RA/

Stewart N. Bailey, Project Manager, Section 2
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* concur by memo; no major revisions

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO APPROVAL OF WELD REPAIR AND PIPE FLAW EVALUATION

AND CHANGES TO REMEDIATION PROGRAM FOR IGSCC-SUSCEPTIBLE WELDS

QUAD CITIES NUCLEAR POWER STATION, UNIT 1

COMMONWEALTH EDISON COMPANY

AND

MIDAMERICAN ENERGY COMPANY

DOCKET NO. 50-254

1.0 INTRODUCTION

By letters dated October 24 and October 25, 2000, as supplemented by letter dated October 27, 2000, Commonwealth Edison Company (ComEd, the licensee) for the Quad Cities Nuclear Power Station, Unit 1 (QC1), informed the NRC of changes in the remediation plan for welds susceptible to intergranular stress corrosion cracking (IGSCC) and requested NRC approval of a pipe flaw evaluation and partial repair for a weld in the reactor recirculation piping at QC1. The approval was requested in accordance with Generic Letter (GL) 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," dated January 25, 1988.

Due to the unexpectedly high primary system dose rates experienced during the current QC1 refueling outage (designated Q1R16), personnel exposures are significantly higher than planned for repairs on the recirculation piping. This has lead ComEd to re-evaluate its plans for weld overlay repairs on three welds. ComEd has proposed that QC1 can operate safely with deferred overlay repairs on welds 02AS-S4 and 02AD-F12, and with a partial weld overlay on weld 02BS-F4.

2.0 BACKGROUND

During the fall 1998 outage at QC1, flaw indications were identified in seven welds in the reactor recirculation piping. During that outage (designated Q1R15), four of the welds received a weld overlay repair in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Case N-504, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1." The remaining three welds (02BS-F4, 02AS-S4 and 02AD-F12) were evaluated and found to be acceptable for operation until the next refueling outage (Q1R16). The licensee's November 24, 1998, submittal describes the flaw evaluations and the plans for overlay repairs of these three welds during the next refueling outage (Q1R16). By letter dated April 16, 1999, the staff found the licensee's proposal to be acceptable, based on a satisfactory evaluation of the re-inspection results or implementation of acceptable repairs during the next refueling outage.

By letter dated March 31, 1999, the licensee described their remediation plan for the welds susceptible to IGSCC. The plan stated that weld overlay repairs would be performed for the above three welds that were categorized as Category F, “Cracked - Inadequate or No Repair,” in accordance with GL 88-01. The staff has reviewed the licensee’s remediation plan and, by letter dated October 13, 2000, determined that the proposed remediation plan will increase the IGSCC resistance of the affected welds, and that the licensee has provided adequate response to resolve the staff’s original concerns.

The licensee stated in its October 24, 2000, letter that, due to higher than expected dose rates, completing the weld overlay repairs on 02AS-S4 and 02AD-F12 would result in significant personnel radiation exposure. Therefore, based on re-inspection results, the licensee was deferring the weld overlays until the next refueling outage.

In its October 25, 2000, letter, the licensee stated that during planning for the 02BS-F4 weld overlay repair, radiation fields in the reactor drywell of less than 250 mrem/hour could be expected, based on experience. Based on this, the licensee estimated that the total radiation dose for the overlay to be 16.1 person-rem. After QC1 was shut down on October 14, 2000, initial drywell surveys revealed actual radiation fields of 900 mrem/hour to 1,100 mrem/hour. Based on this information, the licensee raised the estimate of the total dose to 70 person-rem for the 02BS-F4 weld overlay. Further, despite extensive efforts by the licensee to limit exposure through the use of engineering and human factor controls, the total radiation dose for this weld overlay was increased to 88 person-rem on October 20, 2000, based on actual field experience. As a result, the licensee evaluated the feasibility of deferring completion of this overlay to a future outage for which additional steps such as chemical decontamination would be taken to reduce exposure. The licensee discussed its evaluation and plans with the NRC staff during a conference call on October 20, 2000.

3.0 STAFF EVALUATION

3.1 Deferral of Overlay Repair of Weld 02BS-F4

For weld 02BS-F4, a flaw indication was identified in 1998. Ultrasonic (UT) reflectors were found in the 1989 and 1996 inspections, but were originally evaluated by the licensee as root geometry. The 1998 re-inspection, performed using Performance Demonstration Initiative (PDI) qualified examiners and Electric Power Research Institute (EPRI) qualified procedures, determined that there was an IGSCC indication 0.25 inch deep (approximately 20-percent thru-wall) and 27 inches long in the weld region.

As part of the licensee’s mitigation program to reduce IGSCC susceptibility, the 02BS-F4 weld was subjected to induction heat stress improvement (IHSI) in 1984. Hydrogen water chemistry (HWC) was implemented in 1990, and the plant has been operating with noble metal chemical addition (NMCA, otherwise known as NobleChem™) since April 1999.

The licensee stated that since the 02BS-F4 weld has had two mitigation measures in place since 1990 (IHSI and HWC), the likelihood of a service induced crack during the last 10 years is low, and suggests that the weld had an existing indication since at least 1989. Therefore, the root geometry attributed by the 1989 and 1996 inspections was most likely the IGSCC

indication identified in 1998. The IHSI for this weld had been found by the licensee to be effective in accordance with the EPRI and BWRVIP-61 guidelines for IHSI.

The licensee evaluated the indication in 1998 using IWB-3640 and Appendix C of the 1989 Edition of the ASME Code, Section XI, and the procedures in Appendix C of NUREG-0313, Revision 2, "Technical Report on Material Selection and Process Guidelines for BWR Coolant Pressure Boundary Piping," dated January 1988. Using the crack growth rates for normal water chemistry (NWC), the licensee determined, as discussed below, that the as-left weld would be acceptable for continued operation for two 24-month operating cycles, or until October 2002.

Under the weld classification of GL 88-01, the 02BS-F4 weld is designated as Category F (cracked weld with inadequate or no repair) and would require inspection every outage. However, the licensee determined that a permanent repair, consisting of a full structural overlay that meets ASME Code Case 504-1 requirements, would be performed on the 02BS-F4 weld during the October 2000 outage. The weld overlay application, which would reclassify the weld as a Category E weldment, was stopped after three layers (two layers of overlay plus a finish layer, approximately 0.2 inch total) due to unacceptably high personnel exposure.

The licensee performed a UT inspection of the weld and provided a flaw evaluation in accordance with the ASME Code, Section XI, IWB-3640 and Appendix C. The licensee's flaw evaluation stated that the ASME Code, Section XI, requirements are satisfied by taking structural credit for the weld layers that have already been deposited. The evaluation uses a bounding approach in considering crack growth with HWC and NMCA from the bounding depth of 75 percent pipe thru-wall thickness. Specifics of the licensee's evaluation are discussed below.

3.1.1 <u>QC1 Water Chemistry</u>

The licensee stated that QC1 has been operating with excellent water conductivity, with the overall conductivity ranging from 0.1 to 0.15 µS/cm over the last cycle. The plant has been operating with HWC since 1990 and NMCA was implemented in April 1999. The electro-chemical potential (ECP) history during the last cycle is considerably below -230 mV Standard Hydrogen Electrode (SHE), which indicates that IGSCC crack growth is expected to be negligible under these conditions. Further, the HWC availability was 94.5 percent during 1999 and 96.7 percent during 2000 prior to shutdown for the refueling outage. It can be expected that HWC availability during the coming operating cycle will be comparable. Based on the low conductivity and ECP, it is reasonable to expect extremely low (near zero) growth rates during the coming cycle.

The staff finds, based on the above and the findings in the staff's September 15, 2000, safety evaluation for the EPRI proprietary report TR-113932, "BWR Vessel and Internals Project, Technical Basis for Revisions to Generic Letter 88-01 Inspection Schedules (BWRVIP-75)," dated October 27, 1999, that the licensee has had the elements of an effective HWC program in place since April 1999. This is expected to be beneficial during future operating cycles and supports the licensee's proposed action.

3.1.2 Examination of 02BS-F4 Weld

The partial weld overlay was applied with water-backed welding, giving a heat sink benefit and tending to place the inner diameter (ID) of the pipe under compressive loading, which tends to close the crack and make crack detection by UT means difficult. The licensee performed a combination automated and manual UT examination of the weld overlay volume, and was not able to locate the previously recorded circumferential flaw. However, two lack of bond indications, one upstream and the other downstream of the overlay at the base metal to overlay interface, were recorded by the automated examination. The licensee stated, during a telephone call on October 30, 2000, that the areas of the two indications were approximately 3.46 inches^2 and 7.2 inches^2, for upstream and downstream, respectively, with an average width of 0.261 inch. This meets the lamination criteria of IWB 4513.

The licensee stated that weld shrinkage measurements of the 02BS-F4 weld, taken in the axial direction, showed weld shrinkage of 0.074 inch over the width of the weld (10.97 inches), indicating a compressive strain and confirming compressive stress.

3.1.3 Structural Analysis and Crack Growth Prediction

The licensee provided a structural analysis and crack growth prediction, including a limit load analysis and an evaluation of the applied piping stresses (Attachment 2 to the October 25, 2000, letter). These analyses were performed assuming the crack was 0.25 inch deep and 27 inches long. The crack growth prediction was performed for both NWC and HWC conditions. The licensee's evaluation determined that, under NWC conditions, the crack would grow to less than 50 percent thru-wall and under HWC conditions, would grow to less than 30 percent thru-wall in two cycles of operation. The staff did not accept these analyses since the licensee was unable to verify the initial flaw size.

Pursuant to GL 88-01 guidance for cases where a question exists regarding the UT examination, the licensee performed a flaw evaluation assuming a crack depth of 75 percent thru-wall for the pipe, and taking credit for the 0.2 inch thick weld overlay. As described below, the calculated maximum crack growth was less than the allowable and, thus, the weld is acceptable for an additional cycle of continued operation.

The licensee's flaw evaluation consisted of two parts: the calculation of the allowable flaw depth and the calculation of the predicted flaw depth at the end of the requested period. In the first part, the licensee employed the methodology of IWB-3640 and Appendix C of Section XI of the ASME Code. The loading under consideration includes a pipe pressure of 1000 psi, weight, three types of thermal loading, and seismic loading (OBE and DBE). The upset condition was determined to be limiting, therefore, only loading pertinent to the upset condition (pressure, weight, the bounding thermal, and OBE) and a safety factor of 2.77 were used. In addition, the Z factor for shielded metal arc welding (SMAW) process was used since, except for the root pass, the remaining weld was completed using the SMAW. Figure 1 of the October 27, 2000, submittal shows the resulting allowable flaw as a function of the flaw depth and length. Also shown in Figure 1 is the limit of 75 percent of wall thickness, which represents the ASME Code maximum flaw depth. The 0.2 inch thick weld overlay was included in establishing the 75 percent of wall thickness limit.

In the second part of the flaw evaluation regarding the calculation of the predicted flaw depth at the end of the requested period, the licensee assumed a postulated worst case crack depth of 75 percent of the pipe wall not including the partial overlay. Because QC1 has been operated with HWC since 1990 and NMCA since 1999, the licensee used a crack growth rate of 4.4×10^{-6} in/hour, which is 20 percent of that approved in the safety evaluation for the BWRVIP-14 report. This will give a final flaw depth of 1.007 inches at the next outage. Since it is less than the ASME Code limit of 75 percent of the wall, i.e.,1.08 inches, the licensee concluded that the subject weld meets the ASME Code requirements on flaw evaluation and can be operated with the partially completed weld overlay until the next outage.

The licensee's allowable flaw calculation for the flaw in weld 02BS-F4 in the recirculation piping is in accordance with IWB-3640 and Appendix C of Section XI of the ASME Code. The staff has confirmed the licensee's calculated allowable flaw sizes using the stress intensity (S_m) of 16.9 ksi for the 304 stainless steel at 550 degrees Fahrenheit and the applied membrane stress (P_m) of 5.58 ksi, bending stress (P_b) of 0.368 ksi, and thermal expansion stress of 3.065 ksi, consistent with those provided by the licensee. By comparing the allowable flaw sizes to the additional ASME Code limit of 75 percent thru-wall, the staff concluded that the ASME Code limit of 75 percent thru-wall is limiting and the predicted flaw depth at the next outage shall not exceed this limit. For the IGSCC growth, the HWC since 1990 and the NMCA since 1999 should keep the IGSCC growth at a very low rate; therefore, assuming the reduced growth rate is appropriate.

The licensee's predicted flaw depth at the next cycle (1.007 inches) is less than the allowable limit (1.08 inches) by a small margin. However, IWB-3640 and Appendix C are for actual flaws, not for postulated flaws, and applying the methodology and criteria for actual flaws to postulated flaws is very conservative. Based on the above, the staff agrees with the licensee's conclusion that QC1 can be safely operated with the partially completed weld overlay until the next outage.

3.2 Deferral of Overlay Repair of Welds 02AS-S4 and 02AD-F12

The licensee stated that weld overlay repairs on welds 02AS-S4 and 02AD-F12 were being deferred based on examinations of these welds during Q1R16 using PDI-qualified procedures and personnel. These examinations showed that no growth has occurred. Further, as stated above, higher than expected radiation dose rates were experienced during Q1R16, which would result in significant personnel radiation exposure to complete the planned weld overlay repairs. Based on the above, the licensee concluded that it is technically justified and prudent to defer the planned weld overlays for 02AS-S4 and 02AD-F12 and, thus, eliminate the significant personnel radiation exposure that would be required to perform them.

Based on the staff's review of the licensee's technical justifications for deferring the overlay repairs, the staff finds an additional cycle of operation without weld overlays to be acceptable, but that continued plant operation beyond the next refueling outage is dependent on the satisfactory evaluation of the re-inspection results or implementing acceptable repairs during the next refueling outage.

4.0 CONCLUSION

The staff finds that the licensee's requested actions to (1) defer completion of the weld overlay repair for weld 02BS-F4 and to operate for one additional cycle, and (2) to defer the weld overlay repairs on welds 02AS-S4 and 02AD-F12, to be acceptable.

The staff requests that the licensee inform the staff, within 90 days of the date of this letter, of its plans to (1) reexamine and complete the weld overlay of the 02BS-F4 weld during the next availability (next refueling outage or other extended outage of sufficient duration), and (2) inspect and repair welds 02AS-S4 and 02AD-F12.

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Date: November 7, 2000

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