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

Quad Cities Nuclear Power Station, Unit 2
Facility Operating License Nos. DPR-30
NRC Docket No. 50-265

Subject: Additional Information Supporting Request for Approval of Pipe Flaw Evaluation

Reference: Letter from Keith R. Jury (Exelon Generation Company, LLC) to U. S. NRC, "Request for Approval of Pipe Flaw Evaluation," dated February 22, 2002

In the Referenced letter, Exelon Generation Company (EGC), LLC, submitted a request for NRC approval of a pipe flaw evaluation for a weld in the Reactor Recirculation System piping at Quad Cities Nuclear Power Station (QCNPS), Unit 2 that EGC proposed to leave as-is without repair. The flaw did not meet the acceptance standards of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section XI, 1989 edition, for continued operation without evaluation.

In a February 25, 2002, telephone discussion between Mr. F. Lyon of the NRC and Mr. P. Simpson of EGC concerning the Referenced letter, the NRC requested additional information to complete the review of the proposed request. The attachment to this letter provides the requested information.

Should you have any questions related to this letter, please contact Mr. Patrick R. Simpson at (630) 657-2823.

Respectfully,

J. W. Simpkin
for Keith R. Jury
Director – Licensing
Mid-West Regional Operating Group

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Attachment:

Additional Information Supporting Request for Approval of Pipe Flaw Evaluation QCNPS Unit 2

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station
Office of Nuclear Facility Safety – Illinois Department of Nuclear Safety

Attachment

Additional Information Supporting Request for Approval of Pipe Flaw Evaluation for Quad Cities Nuclear Power Station (QCNPS), Unit 2

Additional Information Request

1) *What is the critical flaw length and depth?*

Response

Since both the length and depth are variables, it is not possible to define explicitly the critical flaw size. The stresses are low enough to tolerate a throughwall crack and still meet the required safety factors of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section XI, 1989 edition (i.e., 2.77 for Normal/Upset and 1.39 for Emergency/Faulted conditions). The following table shows the available safety factors assuming a constant length of 10 inches. The final depth was determined assuming a bounding crack growth rate of 2.58 x 10^{-5} in/hour. Note that this is the bounding value for the maximum K value for a 28 inch diameter pipe as described in NUREG-0313, Revision 2, "Technical Report on Material Selection and Process Guidelines for BWR Coolant Pressure Boundary Piping." It is seen that an initial depth of 0.95 inches would be predicted to become a throughwall crack at the end of the cycle (i.e., 17500 hours) assuming the bounding growth rate. For that limiting condition, the structural margins are well in excess of the ASME B&PV Code required values.

Initial Depth (inch)	Final Depth (inch)	Initial Length (inch)	Final Length (inch)	Structural Margin Upset Conditions	Structural Margin Emergency/Faulted
0.6	1.052	10	10	5.474	4.937
0.7	1.152	10	10	5.366	4.840
0.8	1.252	10	10	5.257	4.742
0.9	1.352	10	10	5.147	4.642
0.95	1.4	10	10	5.092	4.592

In summary, the critical flaw sizes are extremely large and use of conservative crack growth and initial depth values still result in margins in excess of the ASME B&PV Code requirements.

Additional Information Request

2) *For the three approaches used in the crack growth evaluation,*

Additional Information Supporting Request for Approval of Pipe Flaw Evaluation for Quad Cities Nuclear Power Station (QCNPS), Unit 2

(1) *Provide an expanded technical justification for the use of a K value of 21 ksi-in (-.5) in crack growth calculations for the relevant crack depth range; also provide evidence (preferably measured residual stress data) showing that the residual stress distribution of NUREG-0313 is more conservative than that of a IHSI treated piping in your crack growth calculations;*

Response

The K value used was based on the highest K value in NUREG-0313, Revision 2 for the 28 inch diameter pipe in the region of the crack tip. In actuality, the weld was subjected to induction heating stress improvement (IHSI) which will reduce the surface tensile stresses. Therefore, the resulting K value associated with the 0.56 inch flaw depth is expected to be much lower than that assumed in the analysis. In fact, the K value is expected to be maintained below the 21 ksi-in value for depths in excess of one inch.

(2) *Provide an expanded discussion as to how the licensee is following the as-revised guidance of BWRVIP-14, particularly, in meeting the required conditions in conductivity and K value;*

Response

QCNPS, Unit 2 has been operating under NobleChem^{Tm} since February 2000, and the water chemistry meets all Electric Power Research Institute (EPRI) guidelines. Conductivity is maintained below 0.15 μS/cm levels. Hydrogen water chemistry (HWC) system availability has been in excess of 90%. Details are shown below.

- **Electro-chemical potential (ECP) Measurements:** The ECP is measured hourly using the crack arrest verification system (CAVS). The ECP has been running at approximately -490 mV - Standard Hydrogen Electrode (SHE) on both QCNPS units, well below the HWC specification of -230 mV.
- **Durability:** Coupons have been replaced/collected every six months since noble metals injection. All that have been collected are currently being analyzed at General Electric (GE) - San Jose.
- **Molar Ratio:** Benchmark testing was performed on both units after the application of NobleChem^{Tm}. After reviewing the data, GE recommended that the dissolved hydrogen in reactor feedwater be maintained at 0.30 to 0.35 ppm in feedwater at QCNPS. Currently, the hydrogen flow rate of 11 SCFM provides 0.35 ppm dissolved hydrogen in reactor feedwater a value meeting the GE recommendation to assure effective HWC. The effectiveness is confirmed by the ECP measurements.

- **EPRI BWR Water Chemistry Guidelines:** The 2000 Revision of TR-103515-R2 has been implemented at QCNPS. Section 2 of these guidelines is consistent with the equivalent section in BWRVIP-62 on inspection relief for core internals.

Although BWRVIP-14 was intended primarily for reactor internals, the water chemistry, K values, and fluence for reactor recirculation systems all meet the BWRVIP-14 requirements. Thus, it is reasonable to use the NRC Safety Evaluation Report for BWRVIP-14 as a basis for the crack growth rate.

(3) Provide an expanded discussion as to how the licensee is following the as-revised guidance of BWRVIP-75 and BWRVIP-62 to ensure an effective HWC program is implemented; and

Response

As shown in the above response to Question 2, Part 2, the conductivity, hydrogen to oxygen molar ratio, HWC availability etc. are in the range where the FOI exceeds 3. This would assure that the HWC is "effective." The analysis uses a FOI value of 2 for Case 3.

(4) Provide details of Pm, Pb and Pe stresses and equations used in calculating these stresses for both normal/upset and emergency/faulted conditions, so that the staff can perform independent calculations.

Response

The equations used for the analysis are identical to that in ASME Code Section XI, Appendix C, 1989 Edition. The safety factor (SF) is calculated using the following equation:

SF = (Pb' + Pm - Z1*Pe)/{Z1*(Pm + Pb)}

where Z1 is the stress multiplier factor for flux welds and Pm, Pb, Pe are the primary membrane, primary bending and thermal expansion stresses respectively and Pb' is the bending stress corresponding to limit load failure.

The stress inputs are summarized in Table 1.

Attachment

Additional Information Supporting Request for Approval of Pipe Flaw Evaluation for Quad Cities Nuclear Power Station (QCNPS), Unit 2

Table 1
Stress Values Used in the Analysis

Normal Conditions

Pm (ksi)=	5.632	Pm/Sm=	0.333
Pb (ksi)=	0.506	Pb/Sm=	0.030
Pe (ksi)=	0.782	Pe/Sm=	0.046

Upset Conditions

Pm (ksi)=	5.672	Pm/Sm=	0.336
Pb (ksi)=	1.216	Pb/Sm=	0.072
Pe (ksi)=	0.782	Pe/Sm=	0.046

Emergency Conditions

Pm (ksi)=	5.712	Pm/Sm=	0.338
Pb (ksi)=	1.926	Pb/Sm=	0.114
Pe (ksi)=	0.782	Pe/Sm=	0.046

Faulted Conditions

Pm (ksi)=	5.712	Pm/Sm=	0.338
Pb (ksi)=	1.926	Pb/Sm=	0.114
Pe (ksi)=	0.782	Pe/Sm=	0.046