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March 12, 1986

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Quad Cities Station Unit 1
IGSCC Weld Inspection Results
Spring 1986 Refueling Outage
NRC Docket No. 50-254

Reference (a): Letter from J. R. Wojnarowski to H. R. Denton dated October 7, 1985.

Dear Mr. Denton:

Ultrasonic inspection of stainless steel piping susceptible to intergranular stress corrosion cracking (IGSCC) has been completed during the Spring 1986 outage at Quad Cities Station Unit 1. The inspection was conducted in accordance with the plan provided in the reference, as modified by subsequent discussions with your staff. This letter is written to summarize the inspection results and provide Commonwealth Edison's basis for operation of Unit 1 for the next fuel cycle.

In accordance with the guidance in Generic Letter 84-11 and NUREG 1061 (DRAFT), the examination consisted of a total of 58 welds. This total represents an increase of 4 welds from that given in the referenced inspection plan. These additional 28 inch diameter recirculation outlet welds were included in the inspection sample after discussion with your staff. The total sample includes 3 welds with circumferential flaw indications which were overlay repaired during the 1984 refueling outage. Also included was Weld 02BS-S9, which was reported as flawed in 1984 and mitigated with IHSI prior to operation.

The contractor (General Electric) UT personnel making evaluations of indications were requalified for detection and discrimination of IGSCC by the current EPRI program. Final evaluations of indications were reviewed and accepted by Commonwealth Edison Level III UT examiners who have requalified by passing the EPRI practical exam. The depth sizing methodolgy used included dB drop and crack tip diffraction techniques and use of the SLIC-40 transducer.

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The examination results for the welds without an overlay are summarized in Attachment A. Twenty-six (26) welds, including 12 IHSI-treated welds, were examined in both the current (1986) and the previous (1984) refueling outages. There was excellent agreement between the examination results. The one flawed weld (02BS-S9), which was not overlay repaired in 1984, showed no significant change in 1986. In addition, no IGSCC was observed in 29 welds examined for the first time utilizing the current EPRI NDE Center techniques. None of these welds were treated with IHSI. It is noted that the unit operated with excellent water chemistry control during the last fuel cycle. These results were provided to and discussed with your staff on February 13, 1986.

Three weld overlays applied in 1984 to 12-inch pipe-to-elbow recirculation riser welds were ultrasonically examined for the first time. These examinations were mandated by Generic Letter 84-11 and represent all the overlaid welds with reported circumferential flaw lengths greater than or equal to 10% of the pipe circumference. Each of these weld overlays were built-up this outage to accommodate metal removal for surface conditioning; each was built-up sufficiently to assure "full structural" design thickness after surface conditioning. The surface conditioning met the requirements established by CECo for the EPRI-developed weld overlay UT technique. All welds exceeded these surface finish/general contour requirements. All examinations were performed by an EPRI trained and qualified weld overlay examiner in accordance with the recently developed and qualified CECo UT procedure for weld overlays. This procedure was developed, qualified and demonstrated using the weld overlay mock-ups prepared for this purpose. All results were reviewed by the CECo UT Level III personnel responsible for the procedure. Attachment B provides a summary of the results.

No circumferential flaws were observed in the weld overlays or in the outer 1/2t of the original pipe wall. The circumferential indications observed in weld 02K-S3 agreed reasonably well with 1984 results although two of the indications were not observed previously. The examination results for axial flaws compare favorably with the 1984 results and with the steam blow-outs during the weld overlay application. Surface conditioning of the overlay required to apply the EPRI technique lead to detection of additional axial indications, not observed in 1984 inspections prior to application of the weld overlay. There are several instances where ligament measurements indicated that the axial flaw crack tip is in the dilution zone, i.e., that region composed of weld metal and base metal that may not contain sufficient delta ferrite and may not have low enough carbon content to arrest IGSCC. The case (weld 02J-S4) where the axial indications extended into the analytically defined overlay thickness (by a maximum of .050 inches) was typically associated with steam blow-out repairs and an unusually thick first layer. This resulted in the likelihood of leaving the crack tip during repair of the steam blow-out. However, two of these indications were not observed in 1984. These results were discussed with your Staff on March 6, 1986.

All flaws were evaluated against the requirements of Generic Letter 84-11 and ASME Section XI Table IWB-3641-1, as well as the proposed requirements of ASME Section XI Table IWB-3641-5 to account for the possibility of low toughness weldments. Attachment C summarizes the evaluation results, as well as providing the flaw geometry details and the necessary primary and secondary stress combinations. The results demonstrate that the original design margins inherent in the Code for flawed welds have not been degraded and that those overlay-repaired and IHSI-mitigated welds are acceptable for continued service.

The information provided in this letter and its attachments is intended to confirm and supplement the information transmitted in our telephone conversations with your staff. We understand that based on those discussions, your staff considers that Quad Cities Unit 1 can operate for another fuel cycle and intends to document so by letter. Accordingly, startup of Unit 1 is scheduled to commence on March 25, 1986.

One signed original and fifteen (15) copies of this letter and its attachments are provided for your use. If you have any questions regarding the information provided, please contact this office.

Very truly yours,

J. R. Wojnarowski
Nuclear Licensing Administrator

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Attachments

cc: R. Bevan - NRR
NRC Resident Inspector - Quad Cities

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Attachment A

QUAD CITIES STATION - UNIT 1 SPRING 1986 OUTAGE

ULTRASONIC EXAMINATION RESULTS FOR IGSCC SUSCEPTIBLE PIPING

Report 1 - Examination Summary

Quad Cities Unit 1 - Spring 1986 Outage

Examination Sample

Original sample size	55*
No. of weld overlays to be examined	3
Increase in sample size	0
Total number of examinations	58

Examination Status

ISI and SMAD review complete	55

Weld Overlay Surface/Examination

Required	3
In progress	0
Surfacing complete	0
Examination complete	3

Disposition Status

No action required	54
Analytical evaluation required	1

Analysis Status

One flawed pipe analysis required of non-overlaid weld in 1984 examined this outage. Analysis complete and acceptable as-is.

Repairs

None required

* The inspection plan submitted in October 7, 1986 to Mr. H. R. Denton identified 54 welds (including 3 weld overlays) for ultrasonic examination according to the requirements of Generic Letter 84-11. The 58 welds shown as the total number of examinations include 4 additional 28-inch recirculation outlet welds as agreed upon with NRR personnel.

Unit 1 ISI/IGSCC INSPECTION RESULTS

Welds Listed 12

WELD NO.	1984 RESULTS	1986 RESULTS	REMARKS
10AD-S7 (P-E)	ID Geometry	ID Geometry OD Geometry (weld crown)	Geometry confirmed with WSY-70 (1986's)
10AD-S8 (E-P)	Not inspected in 1984	ID Root Geom (360° int.) Low amplitude ID & OD geometry on axial scan.	Geometry confirmed with WSY-70 (1986's)
10AD-S15 (P-Pen.)	Not inspected in 1984	NRI	
10BD-F6 (P-V)	Not inspected in 1984	NRI	
10BD-S7 (E-P)	Not inspected in 1984	ID Root Geom (360° int.)	Geometry confirmed with WSY-70 (1986's)
10BD-S17 (P-Pen.)	Not inspected in 1984	ID Root Geom (360° int.)	
*10BD-F1 (P-Tee)	ID Geom (360°)	ID Root Geom	
10S-F6 (V-E)	Not inspected in 1984	NRI	
10S-S9 (E-P)	Not inspected in 1984	NRI	
10HS-F10A (P-P)	Not inspected in 1984	OD Geom (360° Int.)	
03-F7 (P-E)	NRI	NRI	
*02AD-S6 (E-P)	NRI	OD Geom. (finger damp) ID Signal due to beam redirection	Geom. indications in 1986 probably due to shorter transducer shoe used.

*Mitigated weld(s)

Unit 1 ISI/IGSCC INSPECTION RESULTS

Welds Listed 13

WELD NO.	1984 RESULTS	1986 RESULTS	REMARKS
*O2AS-S4 (E-P)	ID Geom (360° int.)	ID Root Geom (360° int.) OD Geom - finger damp (360° int.)	ID Geom. confirmed with WSY-70 (1986's)
*O2BD-S2 (P-Tee)	NRI	ID Root Geom (360° int.)	ID Geom confirmed with WSY-70 (1986's) Relatively low amplitude signal of ID Geom (1986's)
*O2BD-S6 (E-P)	NRI	NRI	
O2BS-F1 (Noz. SE)	Not inspected in 1984	NRI	
*O2A-S3 (Cross-P)	NRI	NRI	
O2A-S4 (Cross-Red)	NRI	NRI	
O2A-S6 (P-Sweep)	Not inspected in 1984	NRI	
O2A-S7 (P-Sweep)	Not inspected in 1984	NRI	
O2A-S8 (P-Sweep)	NRI	NRI	
O2B-S3 (P-Sweep)	Not inspected in 1984	ID Geom.	
O2B-S4 (P-Sweep)	Not inspected in 1984	NRI	
*O2H-F6 (Sweep-P)	NRI	Low amplitude ID Geom/ Noise noted.	
O2L-F6 (Red-P)	NRI	ID Geom (360° Int)	Less than 50% DAC

*Mitigated weld(s)

Unit 1 ISI/IGSCC INSPECTION RESULTS

Welds Listed 08

WELD NO.	1984 RESULTS	1986 RESULTS	REMARKS
14A-F2 (P-SE)	ID Root Geom (360° Int.)	ID Root Geom. (360° Int.)	
14A-F7 (E-V)	Not inspected in 1984	NRI	
14A-S8 (P-E)	Not inspected in 1984	OD Geom (finger damp)	
14B-F7 (E-V)	Not inspected in 1984	OD Geom (finger damp)	
14B-S8 (E-E)	Not inspected in 1984	OD Geom (finger damp)	
14B-S9 (P-E)	Not inspected in 1984	ID & OD Geom	
14A-F3R (P-P)	NRI	ID Geom. (360° Int)	ID Geom. (360° Int.) was reported during 1980 inspection
**02BS-S9	Pipe Side A. ID Geom (360° Int.) B. 1/2" long x 15% TW (Circ.) C. 1-1/2" long x 18% TW (Circ.) J. —— Elbow Side D. ID Geom E. ID Geom F. ID Geom G. ID Geom H. Slag or Fusion (UTL) I. ID weld indercut (UTL) K. ——	Pipe Side A. ID Geom (360° Int.) B. 1" long x 15% TW (Circ.) C. 1-1/2" long x 24% TW (Circ.) J. ID Geom Elbow Side D. ID Geom E. 1" long x 23% TW (Circ.) F. ID Geom G. ID Geom H. 2-1/2"longx20% TW (Circ.) I. 2-1/2"longx20% TW (Circ.) K. 1" long X 15% TW (Circ.)	No significant crack growth was observed. Minor circumferential crack (K) was observed on the elbow side. New techniques of detection and sizing (WSY-70, SLIC-40 & crack tip diffraction) used in 1986 could be the reason for minor variation between 1984 and 1986 UT results.

**Mitigated weld with known cracks.

Unit 1 ISI/IGSCC INSPECTION RESULTS

Welds Listed 14

WELD NO.	1984 RESULTS	1986 RESULTS	REMARKS
10S-S3 (P-E)	ID Geom (360° Int.)	ID Geom (360° Int.)	
10S-S7 (E-P)	ID Geom (360° Int.)	ID Geom (360° Int.)	
02J-F1 (SE-Noz)	Not inspected in 1984	ID & OD Geom.	
10S-F11 (P-E)	Not inspected in 1984	Counterbore	
10S-F8 (P-E)	Not inspected in 1984	NRI	
10HS-S1A (Flng-Red)	Not inspected in 1984	NRI	
10HS-S2 (E-P)	NRI	NRI	
10HS-S5 (Flng-P)	Not inspected in 1984	NRI	
10HS-S1B (Red-Flng)	Not inspected in 1984	NRI	
03-F8 (V-P)	NRI	NRI	
02K-F1 (SE-Noz)	Not inspected in 1984	NRI	
12S-F28 (E-V)	NRI	NRI	
12S-S26 (P-E)	NRI	ID Geom. (360° Int.)	ID Noise noted on 1984 strip chart
*02AS-F5 (P-P)	NRI	ID Root Geom. (360° Int.)	Inspected in 1986 using automated UT machine

*Mitigated welds

Unit 1 ISI/IGSCC INSPECTION RESULTS

Welds Listed 08

WELD NO.	1984 RESULTS	1986 RESULTS	REMARKS
*O2AS-S3 (P-E)	NRI	ID Root Geom. (360° Int.)	Inspected in 1986 using automated UT machine
N6A-S2 (Flng-SE)	Not inspected in 1984	NRI	
N6B-S1 (SE-Noz)	Not inspected in 1984	ID Geom. (360° Int.)	
N6B-S2 (Flng-SE)	Not inspected in 1984	NRI	
N7-S2 (Flng-SE)	Not inspected in 1984	NRI	
N8A-F1 (Noz-SE)	NRI	NRI	
N8A-F2 (SE-Red)	NRI	ID Geom.	Low amplitude signal of ID Geom. - 55% max.
*1OS-S4 (E-P)	NRI	ID Geom. (360° Int.) OD Geom. (360° Int.)	ID Geom. Max Ampl. 56% OD Geom. Max Ampl. 70%

*Mitigated welds

/dg/7285D

February 10, 1986

Examination Notes - Weld 02BS-S9

Background -

Weld 02BS-S9 is a 28-inch pipe-to-elbow weld in the B-loop pump suction piping of the recirculation system. This weld was examined in June 1984 as part of the augmented ultrasonic examination program during the refueling outage. The weld was IHSI treated during that outage.

1984 Results -

02BS-S9 was examined by the CECo UT contractor (LMT), CECo - SMAD UT Level IIIs and the third party UT contractor (UTL). The evaluation was reported as two circumferential cracks on the pipe side (1/2 inches by 15% and 1-1/2 inch by 18%). A 4 inch long slag or fusion indication was evaluated on the elbow side. ID geometry was noted on the pipe side of the weld intermittently for 360 degrees of circumference. Four discrete locations of ID geometry were identified on the elbow side. These evaluations are detailed in Table One.

1986 Results -

The weld was examined during the current refueling outage by the CECo UT contractor (GE) and CECo - SMAD UT level III personnel. The evaluations of the data are detailed in Table One and summarized as follows:

Pipe side - 1 inch by 15% and 1-1/2 inch by 24%

Three circumferential flaw indications were reported by GE (1 inch long by 15% from 1 to 2 inches clockwise (cw), 0.75 inch by 30% from 4 to 4.75 inches cw, and 4 inches by 20% from 50 to 54 inches cw). The SMAD re-examination confirms the first two of these flaws, but sizes the 0.75 inch long flaw as 1-1/2 inches long by 24% of wall in depth. The indication at 50 to 54 inches cw was evaluated as ID geometry.

Elbow side - 1 inch by 23%, 1 inch by 15%, and 2-1/2 inches by 20%

Three circumferential flaw indications were reported by GE (1 inch by 20% from 9.8 to 10.8 inches cw, 1 inch by 15% from 2 to 3 inches cw, and 2-1/2 inches by 20% from 55 to 57.5 inches cw). The SMAD re-examination confirms the flaw evaluations, with the final sizing (depth) of the flaw from 9.8 to 10.8 inches cw measured as 23%.

Flaw Sizing Methodology -

Flaw depth sizing reported in 1984 utilized the amplitude (dB) drop technique. In 1986, depth sizing was performed using the dB drop technique, crack tip diffraction technique and the SLIC-40 transducer. Reported depths are the results from the crack tip diffraction technique, and in one case the SLIC-40 transducer.

Table One
Ultrasonic Examination Data - Weld 02BS-S9

Indication (1)	Length in.	Start	Stop	Depth, % wall	Examiner(s) (3)	Final Evaluation
1984 - Pipe Side						
A	360 degrees intermit.	-	-	-	LMT/ SMAD	ID geom.
B	0.5	1	1.5	15	UTL/ SMAD	Crack
C	1.5	4	5.5	18	UTL/ SMAD	Crack
1986 - Pipe Side						
A	360 degrees intermit.	-	-	-	GE/ SMAD	ID geom.
B	1	1	2	15	GE/ SMAD	Crack
C	1.5	4	5.5	24	GE/ SMAD	Crack
J	4	50	54	-	GE/ SMAD	ID geom.

Table One (Continued)
Ultrasonic Examination Data - Weld 02BS-S9

Indication (1)	Length in.	Start	Stop	Depth, % wall	Examiner(s) (3)	Final Evaluation
1984 - Elbow Side						
D	1.6	6.6	8.2	-	LMT	ID geom.
E	0.8	10.6	11.4	-	LMT	ID geom.
F	2	62	64	-	LTM	ID geom.
G	0.75	74.1	74.9	-	LMT	ID geom.
H	4	53.7	57.7	(2)	UTL	Slag or fusion
I	0.8	55.5	56.3	-	UTL	ID weld undercut
1986 - Elbow Side						
D	1.5	6	7.5	-	GE/ SMAD	ID geom.
E	1	9.8	10.8	23	GE/ SMAD	Crack
F	2	62	64	-	GE/ SMAD	ID geom.
H/I	2.5	55	57.5	20	GE/ SMAD	Crack
K	1	2	3	15	GE/ SMAD	Crack

(1) Indication designation for comparison purposes between 1984 and 1986 UT examinations.

(2) Depth of 12 mm starting 3 mm from the ID surface reported in 1984.

(3) Examiner(s) performing UT examinations.

Conclusions -

(1) The flaw indications on the pipe side compare well with those reported in 1984. No significant crack growth was observed during the previous fuel cycle.

(2) Minor circumferential cracking was observed on the elbow side. Two of the crack indications were evaluated as ID geometry and slag or fusion during the 1984 examinations.

(3) A shallow, short, circumferential crack indication was evaluated on the elbow side which was not reported in 1984. It is believed this flaw was present in 1984. It is felt that this flaw was observed in 1986 due to the use of enhanced transducers and additional examiner training.

Attachment B

QUAD CITIES STATION - UNIT 1 SPRING 1986 OUTAGE

ULTRASONIC EXAMINATION RESULTS OF WELD OVERLAY REPAIRS

Comparison of Ultrasonic and Visual Observations
Weld 02C-S4
(All Indications - Pipe Side)

Indication	1984 (w/o Weld Overlay) Length, in.	Depth, % wall	Location (center)	1986 (w/ Weld Overlay) Length, in.	Ligament in.	Location (center)	Remarks
Circumferential Flaw Indications -							
C1	4	44	0	Not observed in 1986			Note 1
Axial Flaw Indications -							
A1-A2	1 max.	-	Note 1	0.5	.48/.49	Note 1	Note 2
A3	1 max.	-	Note 1	Not observed in 1986			
A4	Not observed in 1984			0.5	.48	12	
A5	Not observed in 1984			0.3	.66	20	Note 4

Notes:

(1) Intermittent circumferential flaw over 4 inch length centered over 0° marker with three segments. Axial flaws associated with the ends of these circumferential flaws.

(2) These two indications observed as through-wall steam blow-outs in weld overlay application.

(3) A 5/16" by 5/8" area of lack of bond at a ligament depth of 0.65 inch was observed.

(4) Intrados region of elbow-limited scan.

Comparison of Ultrasonic and Visual Observations
Weld 02J-S4
(All Indications - Pipe Side)

Indication	1984 (w/o Weld Overlay) Length, in.	Depth, % wall	Location (center)	1986 (w/ Weld Overlay) Length, in.	Ligament in.	Location (center)	Remarks
Circumferential Flaw Indications -							
C1	4.25	55	1	Not observed in 1986			
C2	0.6	<30	3.5	Not observed in 1986			
C3	2	<30	11	Not observed in 1986			
C4	1.8	<30	21	Not observed in 1986			
C5	1.6	<30	31	Not observed in 1986			
C6	3	<30	35	Not observed in 1986			
Axial Flaw Indications -							
A1-A9	1.1 max.	32-69	--	Eight (8) observed .34 to .46			2 Blow-outs
A10-A11	Not observed			Two (2) observed .34/.44		11 - 12.5	Note 1

Comparison of Ultrasonic and Visual Observations
Weld 02J-S4 (Continued)
(All Indications - Pipe Side)

Indication	1984 (w/o Weld Overlay) Length, in.	Depth, % wall	Location (center)	1986 (w/ Weld Overlay) Length, in.	Ligament in.	Location (center)	Remarks
Axial Flaw Indications (continued) -							
A12	Not observed in 1984			-	.52	19.2	Note 2
A13	Not observed in 1984			-	.42	27.5	
A14-A17	Two (2) blow+outa observed in 1984	31.5 to 33		Four (4) observed	.40-.44	29.5 - 34	Note 1

Notes:

(1) These indications observed as through-wall steam blow-outs in weld overlay application.

(2) Intrados region of elbow - limited scan.

Comparison of Ultrasonic and Visual Observations
Weld 02K-S3
(All Indications - Pipe Side)

Indication	1984 (w/o Weld Overlay) Length, in.	Depth, % wall	Location (center)	1986 (w/ Weld Overlay) Length, in.	Ligament in.	Location (center)	Remarks
Circumferential Flaw Indications -							
C1	1.6	25	3.5	1.5	0.87	4	
C2	0.2	25	3	0.87	0.88	2	
C3	0.8	<15	21	Not observed in 1986			
C4	8	24	28	Not observed in 1986			
C5	Not observed in 1984			1.4	0.77	13.4	Note 3
C6	Not observed in 1986			1.4	0.85	0.5	Note 3
Axial Flaw Indications -							
A1	0.5	25	5	Not observed in 1986			
A2	0.6	18	21	Not observed in 1986			
A3	0.5	14	24	Not observed in 1986			Note 1
A4	0.5	15	26	Not observed in 1986			

Comparison of Ultrasonic and Visual Observations
Weld 02K-S3
(All Indications - Pipe Side)

Indication	1984 (w/o Weld Overlay) Length, in.	Depth, % wall	Location (center)	1986 (w/ Weld Overlay) Length, in.	Ligament in.	Location (center)	Remarks
A5	0.5	-	32	Not observed in 1986			
A6	Not observed in 1984			Not observed in 1986			Note 1
A7	Note 2		28.5	Not observed in 1986			Note 1
A8	I.D. Geometry			0.75	0.42	7.5	

Notes:

(1) These indications observed as through-wall steam blow-outs in weld overlay application.

(2) Observed but not considered a reportable indication in 1984.

(3) It is believed that indications existed but were not observed in 1984 and therefore do not represent new indications. Since there is good correlation in the sizing of circumferential indications observed in 1984 and 1986, it is apparent that no significant crack growth has occurred. This supports the conclusion that these are not new flaws. The depth of all circumferential indications is less than 50% of the pipe wall thickness.

Attachment C

QUAD CITIES STATION - UNIT 1 SPRING 1986 OUTAGE

FLAW EVALUATION/DISPOSITION INFORMATION