COE-301-200
Revision 1
XCE042.0255

EVALUATION AND DISPOSITION OF IGSCC-SUSCEPTIBLE WELDMENTS AT QUAD CITIES NUCLEAR POWER STATION UNIT 2 1993 OUTAGE

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PACIFIC NUCLEAR

REVISION CONTROL SHEET

TITLE: Evaluation and Disposition of IGSCC-Susceptible Weldments at Quad Cities Nuclear Power Station Unit 2 - 1993 Outage (COE-301-200)

DOCUMENT FILE NUMBER: XCE042.0255

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AFFECTED PAGE(S)	DOC. REV.	PREPARED BY/DATE	ACCURACY CHECK BY/DATE	CRITERIA CHECK BY/DATE	REMARKS
iv - vi	0	JKM 8/6/93	CHF 8/7/93	CHF 8/7/93	Initial issue.
1.1 - 1.8	0				(Signatures on file)
2.1 - 2.3	0				
3.1 - 3.6	0				
4.1 - 4.5	0				
5.1 - 5.9	0				
6.1 & 6.2	0				
7.1 & 7.2	0				
A.0 - A.46	0				
B.0 - B.39	0				
C.0 - C.6	0				
D.0 - D.6	0				
5.2-5.3	1	JKM 8/24/93	JWA 8/24/93	JWA 8/24/93	Revised per Client comments

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CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER

I hereby certify that this document and the calculations contained herein were prepared by me or under my direct supervision, and to the best of my knowledge are correct and complete. I further certify that, to the best of my knowledge, design margins required by the original Code of Construction have not been reduced as a result of the activities addressed herein. I am a duly Registered Professional Engineer under the laws of the State of California and am competent to review this document.

Certified by:

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Date: 8/24/93

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1.0 INTRODUCTION

This report summarizes analyses performed by Pacific Nuclear (formerly NUTECH) for evaluation of indications in the Reactor Recirculation and Shutdown Cooling systems at Commonwealth Edison's Quad Cities Nuclear Power Station Unit 2 at the end of its 1993 outage. Since 1983, ultrasonic (UT) examinations of the welds in these systems, as well as the Reactor Water Clean-Up system, have identified flaws judged to be Intergranular Stress Corrosion Cracking (IGSCC). There are currently thirty-seven flawed weldments at Quad Cities Unit 2 including one flawed weld identified and repaired during the 1993 outage. One flawed weldment was replaced in 1983 and three overlay-repaired weldments were replaced in 1990. In addition, two weldments originally identified as flawed in 1983 are now believed to be unflawed. The locations of all the currently flawed welds and two welds which received "load balancing" overlay repairs are shown in Figures 1.0-1 and 1.0-2.

A summary of the overlay application, flawed pipe evaluation, and spool piece replacement history at Quad Cities Unit 2 is shown in Table 1.0-1 and is briefly described below. Appendix A presents descriptions of the IGSCC indications at Quad Cities Unit 2.

This report includes the sustained stress evaluations performed by Pacific Nuclear of unflawed and unrepaired IGSCC-susceptible piping that has had or may receive Stress Improvement (SI).

Q2R6 (1983) Outage

Twenty-three Reactor Recirculation, Shutdown Cooling, and Reactor Water Clean-Up system welds were identified as having flaws during the 1983 outage. Of these welds, nine were repaired with "engineered" weld overlay repairs, one weld (12S-S27) was replaced, and the remaining thirteen were found to be acceptable for continued service based upon flawed pipe criteria. The nine overlay-repaired welds were built-up to "standard" weld overlay repairs during the 1986 outage. Of the thirteen unrepaired welds, two welds (02AS-S6 and 02BS-F14) have since been recharacterized as not having IGSCC; weld 02A-S10 was repaired during the 1986 outage with a "standard" weld overlay repair which experienced significant fabrication defects which were repaired during the 1988 outage, but was eventually replaced during the 1990 outage; two welds (02AS-S4 and 10S-F5) were repaired with "leakage barrier" ("design") weld overlay repairs during the 1985 outage and later built-up to "standard" weld overlay repairs during the 1986 outage; weld 02M-S3 was repaired with an "engineered" weld overlay repair during the 1985 outage and later built-up to a "standard" weld overlay repair during the 1986 outage; weld 02B-S9 was repaired with a "standard" weld overlay repair during the 1986 outage; two welds (02D-S3 and 02M-S4) were repaired with "standard" weld overlay repairs during the 1988 outage; and the remaining four welds were repaired with "standard" weld overlay repairs during the 1990 outage.

The weld overlay repair designs and flawed pipe evaluations performed during the 1983 outage at Quad Cities Unit 2 are described in NUTECH Document No. COM-75-002 (Reference 1).

Q2R7 (1985) Outage

Two Reactor Recirculation system welds (02E-F6A and 02M-F7) were identified as containing flaws and were repaired with "engineered" weld overlay repairs. Both of these welds were built-up to "standard" weld overlay repairs during the 1986 outage.

The weld overlay repair designs and flawed pipe evaluations performed during the 1985 outage at Quad Cities Unit 2 are described in NUTECH Document No. CEC-20-013 (Reference 2).

Q2R8 (1986) Outage

Flaws were detected in five additional Reactor Recirculation system welds. Four of these welds were repaired with "standard" weld overlay repairs. The remaining weld (02BD-F8) was evaluated during the 1986 and 1988 outages using flawed pipe criteria and found to be acceptable for continued service. This last weld was repaired with a "standard" weld overlay repair during the 1990 outage.

The design of weld overlay repairs and evaluations of built-up weld overlay repairs and flawed welds performed during the 1986 outage are described in NUTECH Document No. CEC-73-203 (Reference 3).

Q2R9 (1988) Outage

Twelve new Reactor Recirculation and Reactor Water Clean-Up system welds were identified as having flaws. Eleven were repaired with "standard" weld overlay repairs. Two of these repaired welds (12S-S24 and 12S-F26AR) were replaced during the 1990 outage. The remaining weld (02AD-S6) was evaluated using flawed pipe criteria and found to be acceptable for continued service. This last weld was later repaired with a "standard" weld overlay repair during the 1990 outage. In addition to the "standard" weld overlay repairs on the eleven flawed welds, two unflawed welds (02C-S4 and 02H-S4) received "load leveling" standard weld overlay repairs to reduce (balance) overlay repair axial shrinkage stresses at other unflawed weldments in the Reactor Recirculation system.

The evaluation of the flawed welds and weld overlay repairs applied during the 1988 outage are described in SIA Document No. SIR-88-018 (Reference 4).

Q2R10 (1990) Outage

No new IGSCC flaws were identified during the 1990 outage. However, one weld (02J-S3) which received a "standard" weld overlay repair during the 1988 outage was thought to have significant IGSCC growth into the weld overlay repair. A boat sample taken from this weld conclusively demonstrated that this cracking was arrested at the pipe wall-to-weld overlay repair interface (see Appendix D).

An overall evaluation of the weld overlay repairs applied through the Quad Cities Unit 2 1990 outage is documented in NUTECH Document No. XCL-42-252 (Reference 5).

Q2R11 (1992) Outage

No volumetric ultrasonic examinations of the Reactor Recirculation and Shutdown Cooling system weldments were performed during the 1992 outage.

Q2R12 (1993) Outage

One flawed weld (02C-F7) was identified during this outage and given a "standard" weld overlay repair.

The purpose of this report is to demonstrate that all the Quad Cities Unit 2 flawed weldments meet the requirements of NUREG-0313, Revision 2 (Reference 6) at the end of the 1993 outage. Section 2.0 presents a general description of the implementation requirements used during application of weld overlay repairs at Quad Cities Unit 2. Sections 3.0 and 4.0 provide the evaluation criteria and stresses used in the analysis of overlay repairs. The evaluation methods and results are given in Section 5.0. Sections 6.0 and 7.0 present a summary of conclusions and the references used in the evaluation. Appendix A contains a comparison and description of the flawed weldments identified since the Quad Cities Unit 2 1983 outage. The current as-built dimensions for all the Quad Cities Unit 2 overlays are also presented in Appendix A. Appendix B contains the design drawings for all the current overlays. Appendix C presents the sustained stress magnitudes for all unflawed and unrepaired IGSCC-susceptible welds outside of NUREG-0313 ISI Inspection Category "A". Appendix D provides Commonwealth Edison Company's evaluation of the boat sample extracted from weld 02J-S3 during the 1990 outage.

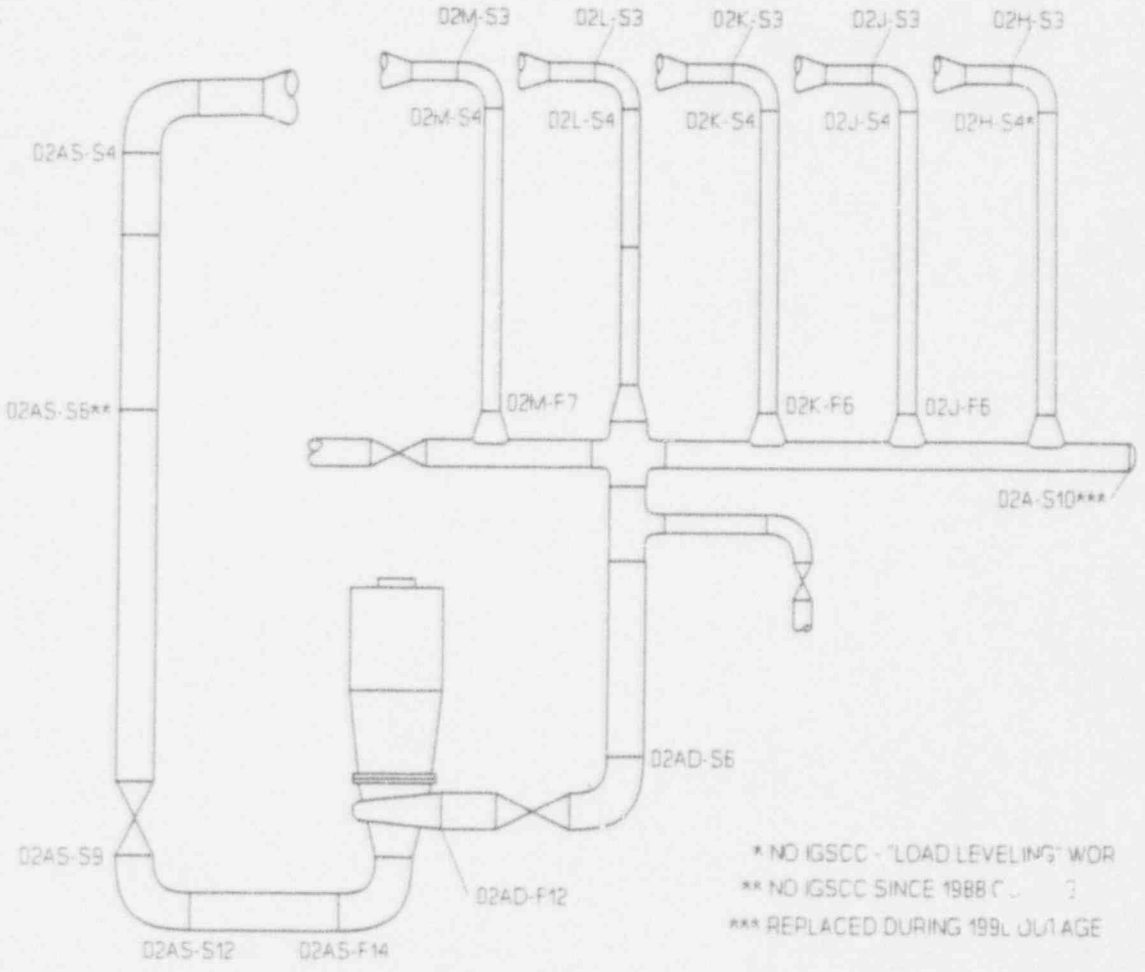


Figure 1.0-1

QUAD CITIES UNIT 2
FLAWED WELD LOCATIONS
REACTOR RECIRCULATION SYSTEM LOOP "A"
(Reference 7)

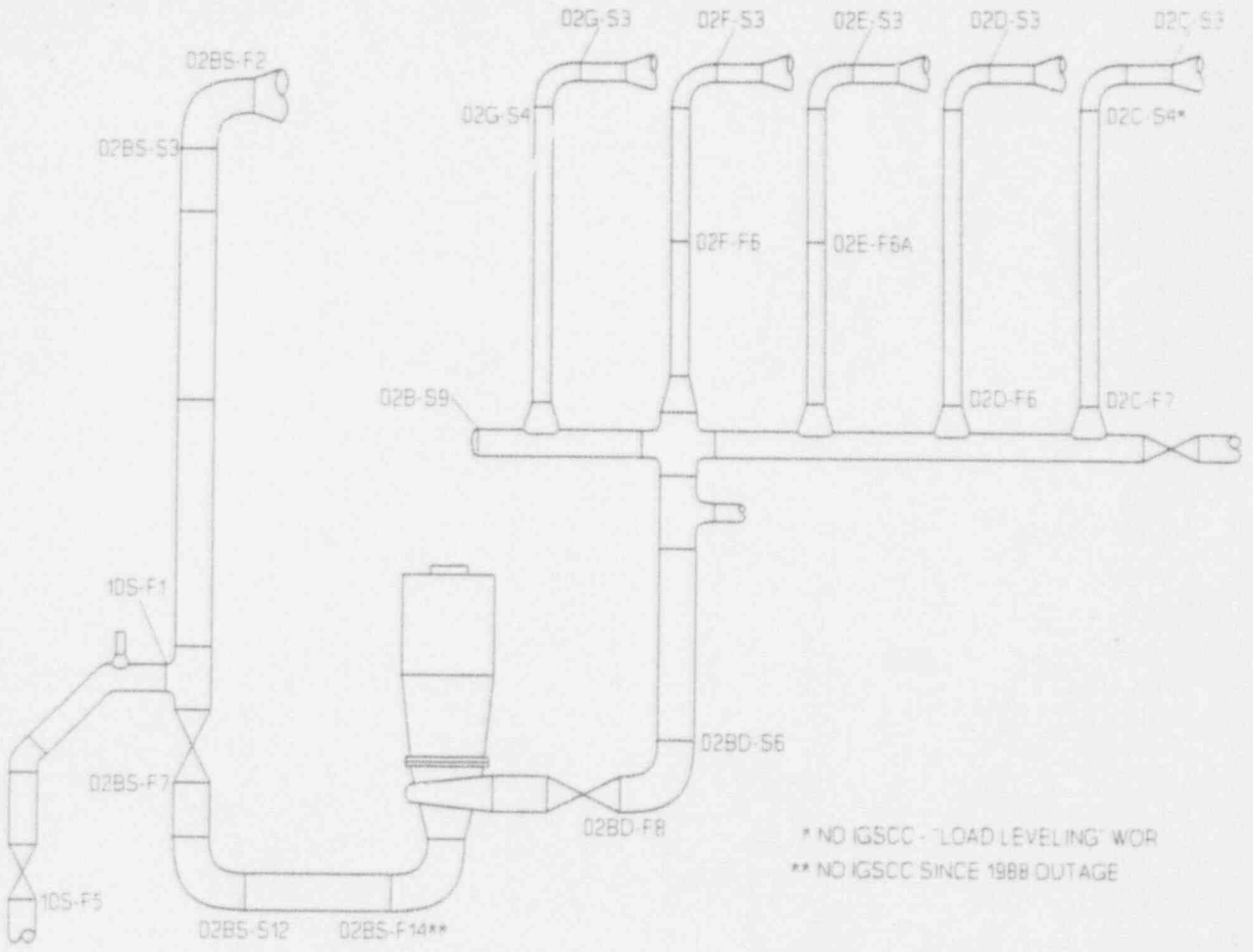


Figure 1.0-2

QUAD CITIES UNIT 2
FLAWED WELD LOCATIONS
REACTOR RECIRCULATION SYSTEM LOOP "B"
AND SHUTDOWN COOLING SYSTEM
(Reference 7)

Table 1.0-1

QUAD CITIES UNIT 2
WELD OVERLAY REPAIR AND FLAWED PIPE EVALUATION
HISTORY SUMMARY

WELD	1983 (Q2R6) OUTAGE	1985 (Q2R7) OUTAGE	1986 (Q2R8) OUTAGE	1988 (Q2R9) OUTAGE	1990 (Q2R10) OUTAGE	1992 (Q2R11) OUTAGE	1993 (Q2R12) OUTAGE
02D-S3	FPE	FPE	FPE	STD			
02D-F6	ENGR		BUS				
02F-F6	ENGR		BUS				
02G-S3	ENGR		BUS				
02J-F6	ENGR		BUS				
02M-S3	FPE	ENGR	BUS				
02M-S4	FPE	FPE	FPE	STD			
02AS-S4	FPE	LB	BUS				
02AS-S6	FPE	FPE	FPE	(1)			
02AS-S9	ENGR		BUS				
02AS-S12	FPE	FPE	FPE	FPE	STD		
02AS-F14	FPE	FPE	FPE	FPE	STD		
02AD-F12	FPE	FPE	FPE	FPE	STD		
02BS-S3	ENGR		BUS				
02BS-F7	ENGR		BUS			N	
02BS-S12	FPE	RGO	RGO	FPE	STD	O	
02BS-F14	FPE	FPE	RGO	(1)		T	
02BD-S6	ENGR		BUS				
02A-S10	FPE	FPE	STD	(2)	REPLACED	I	
02B-S9	FPE	FPE	STD			N	
10S-F1	ENGR		BUS			S	
10S-F5	FPE	LB	BUS			P	
12S-S27	REPLACED					E	
02E-F6A		ENGR	BUS			C	
02N-F7		ENGR	BUS			T	
02C-S3			STD			E	
02K-S3			STD			D	
02K-S4			STD				
02BS-F2			STD				
02BD-F8			FPE	FPE	STD		
12S-S24				STD	REPLACED		
12S-F26AR				STD	REPLACED		
02E-S3				STD			
02F-S3				STD			
02G-S4				STD			
02H-S3				STD			
02J-S3				STD	(3)		
02J-S4				STD			
02K-F6				STD			
02L-S3				STD			
02L-S4				STD			
02AD-S6				FPE	STD		
02C-S4				LL			
02H-S4				LL			
02C-F7							STD

ABBREVIATIONS:
FPE - Flawed Pipe Evaluation Performed
STD - "Standard" Weld Overlay Applied
RGO - Root Geometry Only
LL - Unflawed, "Load Leveling" Overlay Applied
ENGR - "Engineered" Overlay Applied
BUS - Built-Up To "Standard" Overlay
LB - "Leakage Barrier" Overlay Applied

NOTES:
(1) - No IGSCC reported.
(2) - Fabrication defects from 1986 outage repaired.
(3) - Boat samples extracted, manually repaired, and one additional GTAW layer applied.

2.0 OVERLAY DESCRIPTION

At the end of the 1993 outage, a total of thirty-nine overlays exist at Quad Cities Unit 2. Thirty-seven of these overlays are "standard" overlay repairs and two have been applied as "load leveling" overlays using "standard" overlay repair designs.

All of the overlays were made by increasing the pipe wall thickness through the deposition of weld metal 360° around and to either side of the existing weld. The weld-deposited band provides additional wall thickness to restore the original Code safety margin. Because of waterbacking, the welding process produces a strong compressive residual stress pattern on the inside portion of the pipe wall (as discussed in Reference 8) thereby preventing further crack growth. The deposited weld metal is either Type 308L or Type 309L with controlled delta ferrite content so as to be resistant to the propagation of IGSCC. The overlay design drawings are presented in Appendix B while the current as-built information for all overlays is in Appendix A.

The application of an overlay causes a small amount of axial shrinkage underneath the overlay. These shrinkages cause additional stresses at other locations in the piping system and their effect must be evaluated. The as-measured shrinkages compiled from work packages for each overlay are shown in Appendix A.

The nondestructive examination (NDE) requirements for each overlay applied at Quad Cities Unit 2 consisted of the following:

1. Surface examination of the existing pipe surface by the liquid penetrant testing (PT) technique in accordance with ASME Section XI. All PT indications were repaired prior to application of the weld overlay. Acceptable repair methods were as follows:

   a. For indications which are the result of geometric conditions (e.g., overlap, undercut, grinding marks, and scratches), the indications were removed by grinding prior to weld overlay application. No welding of the ground cavity was required.

   b. For any linear indication, regardless of length, and for any rounded indication in the region of the original weld heat-affected zone (HAZ), the indications were weld repaired after removal.

   After repairs, the existing pipe surface was re-PT examined and re-repaired, if required, until found acceptable.

2. Delta ferrite content measurement of the first layer of new overlays or the first layer to increase the length of an existing overlay.

3. Enhanced visual examination of the first overlay layer for evidence of IGSCC flaws for new and built-up overlays (discoloration, porosity, etc.).

4. Surface examination of the completed overlay by the PT technique using methods in accordance with ASME Sections V and XI. All PT indications were reported to CECo for resolution.

5. Volumetric examination of the completed overlay and part of the original pipe wall by the ultrasonic testing (UT) technique developed by EPRI.

All UT examinations were performed by EPRI-qualified examiners.

3.0 EVALUATION CRITERIA

3.1 Weld Overlay Repair Evaluation

All "standard" weld overlay repairs at Quad Cities Unit 2 were designed to meet the requirements of NUREG-0313. The following criteria were used by Pacific Nuclear to design/evaluate all of the weld overlay repairs listed in Appendix A:

1. For welds with circumferential flaws, the circumferential flaw depth was assumed to equal the greater of 100% of the original pipe wall thickness or the depth associated with the smallest remaining ligament by a conservative 360° length.

2. For welds with axial flaws, the axial flaw depth was assumed to be 100% of the original pipe wall thickness with a length equal to the greater of 1.5 times the pipewall thickness or its measured length. If an axial flaw was drawn up into the overlay due to a steam blow-out, the actual flaw depth was used.

3. Credit was taken for the first layer if the delta ferrite content was at least 7.5 FN. If the ferrite content was below this value, any circumferential or axial flaws were assumed to extend through the first layer.

4. A bounding under-the-overlay fatigue crack growth of 0.005 inch was used in the overlay design. This was established based on analyses performed by Pacific Nuclear in References 1, 2, and 3 using a conservative crack growth correlation derived from data presented in Reference 9.

5. For circumferential flaws, the weld overlay repair strength for a combination of dead weight, internal pressure, and seismic stresses was compared to the net section plastic collapse criteria of ASME Section XI, Table IWB-3641-1 (Reference 10). Because this table has an arbitrary cut-off point at a stress ratio of 0.6, Pacific Nuclear has developed an expanded version (Table 3.1-1) based upon the source equations shown in Figure 3.1-1.

6. For axial flaws, the weld overlay repair was compared to "leakage barrier" weld overlay repair criteria presented in Table 3.1-2 from NUTECH Document COM-76-001 (Reference 11).

3.2 Evaluation of Sustained Stresses at Unflawed Locations

As part of CECo's IGSCC mitigation program, various IGSCC-susceptible piping welds at Quad Cities Unit 2 have been mitigated by the Induction Heating Stress Improvement (IHSI) process or the Mechanical Stress Improvement Process (MSIP). Other susceptible welds may be considered for future stress improvement (SI) mitigation. Because the effectiveness of SI treatment is related to the applied stress acting on a weldment, it is recommended in Supplement 1 to Generic Letter 88-01 (Reference 12) that the service or sustained stress (unintensified internal pressure + dead weight + thermal expansion + weld overlay shrinkage stresses) for weldments receiving SI treatment be evaluated. The sustained stresses for unflawed and unrepaired welds outside of NUREG-0313 ISI Inspection Category "A" in various susceptible systems are tabulated in Appendix C.

Table 3.1-1

EXPANDED ALLOWABLE END-OF-EVALUATION PERIOD
FLAW DEPTH-TO-THICKNESS RATIOS FOR CIRCUMFERENTIAL FLAWS IN
BASE METAL OR GTAW WELDMENTS DURING NORMAL OPERATING CONDITIONS
(see Note 1)

STRESS RATIO (Note 2)	RATIO OF FLAW LENGTH (L) TO PIPE CIRCUMFERENCE (Note 3)					
	0.0	0.1	0.2	0.3	0.4	≥0.5
1.5	(4)	(4)	(4)	(4)	(4)	(4)
1.4	0.75	0.40	0.21	0.15	(4)	(4)
1.3	0.75	0.75	0.39	0.27	0.22	0.19
1.2	0.75	0.75	0.56	0.40	0.32	0.27
1.1	0.75	0.75	0.73	0.51	0.42	0.34
1.0	0.75	0.75	0.75	0.63	0.51	0.41
0.9	0.75	0.75	0.75	0.73	0.59	0.47
0.8	0.75	0.75	0.75	0.75	0.68	0.53
0.7	0.75	0.75	0.75	0.75	0.75	0.58
0.6	0.75	0.75	0.75	0.75	0.75	0.63
0.5(5)	0.75	0.75	0.75	0.75	0.75	0.68
0.4(5)	0.75	0.75	0.75	0.75	0.75	0.73
≤0.36(5)	0.75	0.75	0.75	0.75	0.75	0.75

NOTES:

(1) Flaw Depth = "a" for a surface flaw or
"2a" for a subsurface flaw.
"t" = nominal thickness.
Linear interpolation is permissible.

(2) Stress Ratio = $(P_m + P_b)/S_m$

where:

P_m = primary longitudinal membrane stress ($P_m \leq 0.5S_m$).
P_b = primary bending stress.
S_m = allowable design stress intensity in accordance with ASME Section III (Reference 13).

(3) Circumference based upon nominal pipe diameter;
"L" = end-of-evaluation period flaw length.

(4) IWB-3514.3 shall be used.

(5) Derived using source equations (Figure 3.1-1).

Table 3.1-2

LEAKAGE BARRIER REPAIR CRITERIA
FOR AXIAL FLAWS
(Reference 11)

STRESS RATIO (Note 1)	NONDIMENSIONAL FLAW LENGTH (Note 2)				
	0.00	0.25	0.50	1.00	≥ 2.00
1.00	(3)	(3)	(3)	(3)	(3)
0.95	(4)	(4)	(3)	(3)	(3)
0.90	(4)	(4)	(4)	(3)	(3)
0.80	(4)	(4)	(4)	(4)	(3)
0.70	(4)	(4)	(4)	(4)	(3)
0.60	(4)	(4)	(4)	(4)	(3)
0.50	(4)	(4)	(4)	(4)	(3)
≤0.40	(4)	(4)	(4)	(4)	(3)

NOTES:

(1) Stress Ratio = $(P * OD)/(2 * t * S_m)$

where:

P = maximum pressure for normal operating conditions.
OD = nominal outside diameter of pipe.
t = nominal thickness.
S_m = allowable design stress intensity in accordance with ASME Section III (Reference 13).

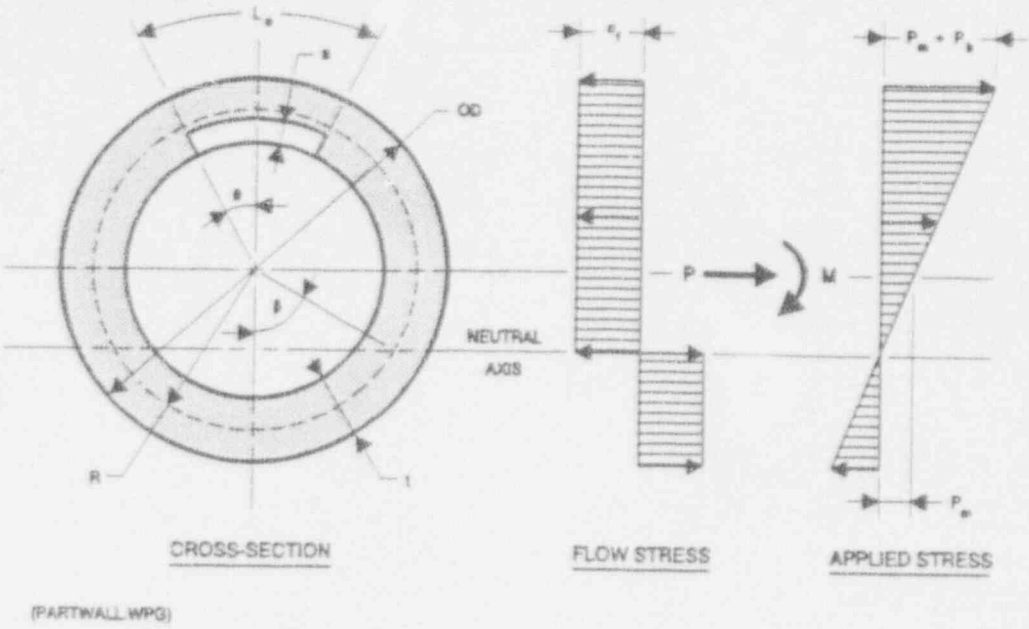
(2) Nondimensional Flaw Length = $\frac{L}{\sqrt{R*t}}$

where:

R = Nominal radius of pipe.
L = end-of-evaluation period flaw length.

(3) IWB-3640 shall be used.

(4) Only a "Leakage Barrier" weld overlay repair is required ($t \geq 0.125$").



(PARTWALL.WPG)

FOR $\theta + \beta < 180°$:

$$\beta = \frac{\frac{5}{6}\pi - \theta\frac{a}{t}}{2} \text{ (radians)}$$

$$SF(SR) - 0.5 - \frac{6}{\pi}\left(2 \sin \beta - \frac{a}{t} \sin \theta\right) = 0$$

FOR $\theta + \beta \geq 180°$:

$$\beta = \frac{\pi\left(\frac{5}{6} - \frac{a}{t}\right)}{2 - \frac{a}{t}} \text{ (radians)}$$

$$SF(SR) - 0.5 - \frac{6}{\pi}\left(2 - \frac{a}{t}\right)\sin \beta = 0$$

Figure 3.1-1

SOURCE EQUATIONS FOR ALLOWABLE END-OF-EVALUATION PERIOD FLAW DEPTH-TO-THICKNESS RATIOS FOR CIRCUMFERENTIAL FLAWS

where:

θ = half-crack angle (radians)

L_c = total circumferential crack length

β = neutral axis location angle (radians)

a = flaw depth (inches)

t = pipe thickness (inches)

OD = outside pipe diameter (inches)

R = mean pipe radius (inches) = (OD - t) / 2

S_m = allowable design stress intensity

P_m = primary longitudinal membrane stress ($\leq 0.5S_m$)

P_b = primary bending stress

P_e = unconcentrated expansion stress

For Base Metal and GTAW Weldments:

$$SR = \frac{P_m + P_b}{S_m}$$

SF = 2.77

For SMAW Weldments:

M = 1.0 when OD $\leq$ 24"

M = 1.0 + 0.01(OD - 24) when OD > 24"

For SMAW and SAW Weldments:

$$SR = \frac{M(P_m + P_b + \frac{P_e}{SF})}{S_m}$$

SF = 2.77 x 1.449 = 4.018

For SAW Weldments:

M = 1.08 when OD $\leq$ 24"

M = 1.08 + 0.009(OD - 24) when OD > 24"

Figure 3.1-1

SOURCE EQUATIONS FOR ALLOWABLE END-OF-EVALUATION PERIOD FLAW DEPTH-TO-THICKNESS RATIOS FOR CIRCUMFERENTIAL FLAWS
(Concluded)

4.0 STRESSES

As discussed in Section 3.0, various stress combinations are used in evaluating weld overlay repairs and sustained stresses acting on unflawed and unrepaired welds. This section presents the stresses acting on the welds discussed in this report.

4.1 Primary Stresses

Primary stresses include the effects of deadweight, internal pressure, and seismic loads. The design pressure of 1,250 psi was obtained from IMPELL, Sargent & Lundy, and Pacific Nuclear piping system analyses (References 14 through 19). The deadweight and seismic stresses applied to each weld were also obtained from these references. The magnitudes of these stresses acting on weld overlay repairs are shown in Table 4.1-1. The magnitudes of these stresses used in the sustained stress evaluation of unflawed and unrepaired welds are shown in Appendix C.

4.2 Secondary Stresses

Secondary stresses include the following:

1. Thermal Stresses

   The piping system differential thermal expansion stresses used in the sustained stress evaluations presented in this report were obtained from IMPELL, Sargent & Lundy, and Pacific Nuclear piping system analyses (References 14 through 19).

2. Weld Overlay Shrinkage-Induced Stresses

Each weld overlay causes a small amount of axial shrinkage underneath the overlay. This shrinkage primarily induces bending stresses at other locations in the piping system. These shrinkage-induced stresses are calculated using the Pacific Nuclear computer program PISTAR (Reference 20). Figure 4.2-1 presents the piping model used. This model includes the Reactor Recirculation, Residual Heat Removal (Low Pressure Coolant Injection and Shutdown Cooling), and Reactor Water Clean-Up systems inside the drywell. The actual as-built shrinkages as presented in Appendix A are used in the analysis. The resulting shrinkage stresses are included in the sustained stress evaluations presented in this report.

4.3 Sustained Stress Evaluation at Unflawed Weld Locations

As discussed in Section 3.2, sustained stresses at unflawed and unrepaired weld locations outside of NUREG-0313 ISI Inspection Category "A" should be evaluated. This evaluation is limited to the following susceptible systems listed in CECo's response to Generic Letter 88-01 for Quad Cities Unit 2:

A) Reactor Recirculation
B) Shutdown Cooling
C) Low Pressure Coolant Injection (LPCI)
D) Core Spray
E) Reactor Water Clean-Up (RWCU)
F) Jet Pump Instrumentation Nozzles
G) Head Vent Nozzle
H) Spare Nozzles

The sustained stress level at a weld location consists of unintensified internal pressure, dead weight, thermal expansion and weld overlay-induced shrinkage stresses. Initially, a review was made of piping systems that do not presently have weld overlay repairs. This was done to determine if the original design code compliance of these systems could be used to verify that the sustained stress limits were met. It was realized that a general statement to this effect cannot be made for plants designed under USAS B31.1.0 because the design allowables are not related to S_m. Furthermore, stress intensification factors used in the design make such an evaluation incompatible with the requirements of NUREG-0313. The sustained stresses were, therefore, calculated on a system unique basis for the susceptible systems listed above. The jet pump instrumentation, head vent, and spare nozzles are affected by internal pressure only and, therefore, are not addressed in this document. The RWCU system currently contains only NUREG-0313 ISI Category "A" weldments, therefore, it is not further addressed in this document. The sustained stresses for the welds in the remaining systems are presented in Appendix C.

Table 4.1-1

QUAD CITIES UNIT 2
APPLIED STRESSES FOR WELD OVERLAY REPAIR EVALUATIONS

WELD ID	DESIGN PIPE WALL THK. (t_{pd}) (inches)	PRESSURE STRESS (P) (psi)	DEADWEIGHT STRESS (DW) (psi)	SEISMIC STRESS (OBE) (psi)	TOTAL OVERLAY STRESS[1] (psi)
02C-S3	0.653	6102	372	590	7064
02C-S4[2]	0.690	5775	516	1106	7397
02C-F7	0.687	4642	397	1850	6389
02D-S3	0.669	5956	213	841	7010
02D-F6	0.595	6696	475	2604	9775
02E-S3	0.656	6074	109	1030	7213
02E-F6A	0.653	6102	342	2354	8798
02F-S3	0.661	6027	23	1202	7252
02F-F6	0.590	6753	736	3452	10941
02G-S3	0.662	6019	186	1511	7716
02G-S4	0.711	5940	240	805	6985
02H-S3	0.684	5825	120	1170	7115
02H-S4[2]	0.680	5859	156	1287	7302
02J-S3	0.826	4824	73	1033	5930
02J-S4	0.651	6001	96	744	6841
02J-F6	0.648	6149	274	2317	8740
02K-S3	0.664	6001	91	1231	7323
02K-S4	0.673	5921	24	689	6634
02K-F6	0.603	6608	418	3292	10318
02L-S3	0.664	6001	112	1557	7670
02L-S4	0.678	5974	149	1119	7242
02M-S3	0.662	6019	240	1272	7531
02M-S4	0.684	5825	180	1048	7053
02M-F7	0.570	6991	647	3532	11170
02B-S9	1.184	5802	0	4	5806
02AD-S6	1.432	6110	360	673	7143
02AD-F12	1.377	6448	528	1825	8801
02AS-S4	1.425	6141	182	354	6677
02AS-S9	1.363	6415	228	400	7043
02AS-S12	1.387	6308	156	848	7312
02AS-F14	1.360	6434	204	1180	7818
02BD-S6	1.420	6158	432	549	7139
02BD-F8	1.455	6263	255	435	6953
02BS-F2	1.393	6281	110	359	6750
02BS-S3	1.418	6171	302	234	6707
02BS-F7	1.250	7000	324	455	7779
02BS-S12	1.417	6175	168	342	6685
10S-F1	1.016	6152	912	3090	10154
10S-F5	1.021	6122	333	390	6845

NOTES:

(1) Total Overlay Stress = P + DW + ODE.

(2) Unflawed weld.

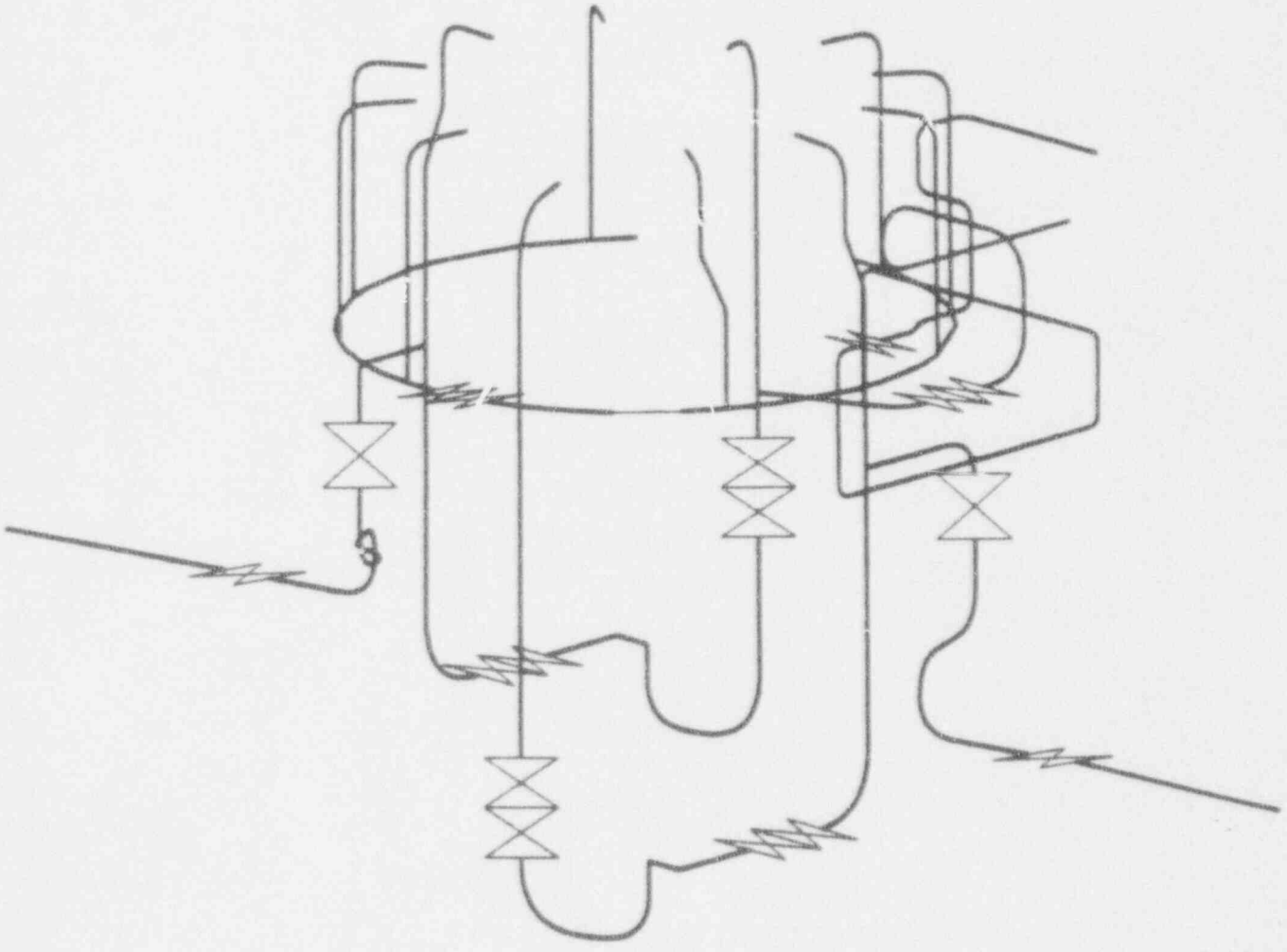


Figure 4.2-1

WELD OVERLAY SHRINKAGE ANALYSIS MODEL

5.0 EVALUATION METHODS AND RESULTS

This section contains the evaluation methods and results utilized to assess the acceptability of the overlay-repaired weldments at Quad Cities Unit 2.

5.1 Weld Overlay Repair Evaluation

Tables 5.1-1 and 5.1-2 present the pipe, weld overlay repair, and flaw geometry details needed to calculate the applied stress and flaw depth ratios for all the circumferentially flawed overlay-repaired welds at Quad Cities Unit 2. Applied stresses are found in Table 4.1-1. Table 5.1-3 presents a comparison of predicted flaw depth ratios due to applied loads versus the allowable flaw depth ratios for the circumferential flaws detailed in Table 5.1-2. As discussed in Section 3.1, the allowable flaw depth ratios shown were determined from Table 3.1-1. As a result, all the weld overlay repairs presented in Table 5.1-1 meet NUREG-0313, Revision 2 "standard" overlay requirements.

Tables 5.1-4 and 5.1-5 show the pipe and flaw geometric details needed to determine predicted and allowable "leakage barrier" remaining ligament thicknesses for all the overlay-repaired welds at Quad Cities Unit 2. Table 5.1-6 presents a comparison of predicted remaining ligament thicknesses for the weldments given in Table 5.1-4 with allowable remaining ligament thicknesses determined using the "leakage barrier" criteria presented in Table 3.1-2.

reportable indications" in this weldment. Therefore, Pacific Nuclear's modified weld overlay repair evaluation approach appears to be overly conservative for this weldment. Accordingly, Pacific Nuclear believes that the following approach should be utilized for this weldment:

a	= 1.184" + 0.005"	= 1.189"
t	= 1.184" + (0.514" - 0.113")	= 1.585"
a/t	= 1.189"/1.585"	= 0.75

Therefore, weld 02B-S9 is acceptable per NUREG-0313 and ASME Section XI acceptance criteria.

5.3 Weld 02C-F7 Discussion

One flawed weld (02C-F7) was identified during this outage and given a "standard" weld overlay repair. The delta ferrite measurement for the first layer was greater than the required 7.5 FN at all locations as indicated in Table 5.1-1. The finished thickness of the overlay was 0.406" as indicated in Table 5.1-1.

The effect of the 02C-F7 overlay on the deadweight and stiffness of the piping system is negligible. The additional weight of the overlay is less than 1/4 of a pipe diameter (< 20 lbs.) and the thickened overlay section is less than 4" wide on a riser that is over 17 feet long.

The effect of the 02C-F7 overlay shrinkage upon pipe supports and whip restraints is also negligible. The maximum piping displacement from this overlay is approximately 0.14" which is within normal pipe support tolerances for gaps/clearances. Thus pipe support travel and restraint clearances will not require modification.

5.2 Weld 02B-S9 Discussion

Weld 02B-S9 received a "standard" weld overlay repair during the 1986 outage. Because the primary stress load combination acting on this weld is low, this overlay had a conservative design thickness of 0.38" based upon a design pipe wall thickness of 0.979". The minimum as-built overlay thickness for this weld, excluding the low ferrite content first layer, is 0.401" (see the Reference 3 NUTECH report).

Since the 1986 outage, Pacific Nuclear has conservatively modified its approach for the evaluation of weld overlay repairs. As shown in Tables 5.1-1 and 5.1-2, this modified approach now bases the evaluation flaw depth on the as-built thickness of the flawed pipe wall and any low ferrite content layers. For weld 02B-S9, the critical as-built pipe wall thickness is 1.184", the low ferrite content first layer thickness is 0.113", and the total weld overlay repair thickness is 0.514". Using a balance-of-plant life fatigue crack growth depth of 0.005" results in the following:

a (flaw depth)	= 1.184" + 0.113" + 0.005"	= 1.302""
t (thickness)	= 1.184" + 0.514"	= 1.698"
a/t	= 1.302"/1.698"	77

This value is slightly greater than the Table 3.1-1 maximum allowable a/t value of 0.75 for a flawed component having an applied stress ratio of only 0.24.

A review of the 1988 outage volumetric ultrasonic examination (UT) results for this weldment (Appendix A) show that all detectable circumferential indications are below the low ferrite content first layer. The 1990 and 1993 outage volumetric UT examinations (also in Appendix A) found "no

Table 5.1-1

QUAD CITIES UNIT 2
CIRCUMFERENTIALLY FLAWED OVERLAY-REPAIRED WELDS
PIPE AND WELD OVERLAY REPAIR GEOMETRY DETAILS

WELD ID	NOMINAL PIPE OD[1] (inches)	MAXIMUM PIPE WALL THK. (t_p) (inches)	MIN. TOTAL OVERLAY THK. (t_o) (inches)	LOW FN 1ST LAYER THK. (t_1)[2] (inches)	TOTAL THK.(t)[3] (inches)
02C-S3	12.750	0.653	0.355	N/A	1.008
02C-S4[4]	12.750	0.690	0.343	N/A	1.033
02C-F7	12.750	0.684	0.406	N/A	1.090
02D-S3	12.750	0.669	0.293	N/A	0.962
02D-F6	12.750	0.595	0.329	N/A	0.924
02E-S3	12.750	0.656	0.351	N/A	1.007
02E-F6A	12.750	0.653	0.314	N/A	0.967
02F-S3	12.750	0.661	0.303	N/A	0.964
02F-F6	12.750	0.590	0.355	N/A	0.945
02G-S3	12.750	0.662	0.307	N/A	0.969
02G-S4	12.750	0.711	0.253	N/A	0.964
02H-S3	12.750	0.684	0.326	N/A	1.010
02H-S4[4]	12.750	0.680	0.313	N/A	0.993
02J-S3	12.750	0.826	0.378	N/A	1.204
02J-S4	12.750	0.651	0.280	N/A	0.931
02J-F6	12.750	0.648	0.372	N/A	1.020
02K-S3	12.750	0.664	0.298	N/A	0.962
02K-S4	12.750	0.673	0.309	N/A	0.982
02K-F6	12.750	0.603	0.316	N/A	0.919
02L-S3	12.750	0.664	0.333	N/A	0.997
02L-S4	12.750	0.678	0.323	N/A	1.001
02M-S3	12.750	0.662	0.404	N/A	1.066
02M-S4	12.750	0.684	0.291	N/A	0.975
02M-F7	12.750	0.570	0.512	N/A	1.082
02B-S9	22.000	1.184	0.514	0.113	1.698
02AD-S6	28.000	1.432	0.497	N/A	1.929
02AD-F12	28.000	1.377	0.575	N/A	1.952
02AS-S4	28.000	1.425	0.499	N/A	1.924
02AS-S9	28.000	1.363	0.488	N/A	1.851
02AS-S12	28.000	1.387	0.557	N/A	1.944
02AS-F14	28.000	1.360	0.570	N/A	1.930
02BD-S6	28.000	1.420	0.530	N/A	1.950
02BD-F8	28.000	1.455	0.540	N/A	1.995
02BS-F2	28.000	1.393	0.508	N/A	1.901
02BS-S3	28.000	1.418	0.492	N/A	1.910
02BS-F7	28.000	1.250	0.484	N/A	1.734
02BS-S12	28.000	1.417	0.525	N/A	1.942
10S-F1	20.000	1.016	0.491	N/A	1.507
10S-F5	20.000	1.021	0.543	N/A	1.564

NOTES:

(1) OD = outside diameter.
(2) Low ferrite number (FN) first layer thickness.
(3) Total thickness = $t_p + t_o$.
(4) Unflawed welds.
(5) All thickness dimensions are as-built dimensions.

Table 5.1-2

QUAD CITIES UNIT 2
CIRCUMFERENTIALLY FLAWED OVERLAY-REPAIRED WELDS
FLAW GEOMETRY DETAILS

WELD ID	EVALUATION FLAW LENGTH (L)			EVALUATION FLAW DEPTH (a)			
	"L"	Inches or Degrees	α[1] (radians)	t_p[2] (%)	a_f[3] (inches)	t_r[4] (inches)	a[5] (inches)
02C-S3	360	DEG.	3.14	100	0.005	N/A	0.658
02C-S4[6]	360	DEG.	3.14	100	0.005	N/A	0.695
02C-F7	360	DEG.	3.14	100	0.005	N/A	0.689
02D-S3	360	DEG.	3.14	100	0.005	N/A	0.674
02D-F6	360	DEG.	3.14	100	0.005	N/A	0.600
02E-S3	360	DEG.	3.14	100	0.005	N/A	0.661
02E-F6A	360	DEG.	3.14	100	0.005	N/A	0.658
02F-S3	360	DEG.	3.14	100	0.005	0.61	0.666
02F-F6	360	DEG.	3.14	100	0.005	N/A	0.595
02G-S3	360	DEG.	3.14	100	0.005	0.65	0.667
02G-S4	360	DEG.	3.14	100	0.005	N/A	0.716
02H-S3	360	DEG.	3.14	100	0.005	N/A	0.689
02H-S4[6]	360	DEG.	3.14	100	0.005	N/A	0.685
02J-S3	360	DEG.	3.14	100	0.005	N/A	0.831
02J-S4	360	DEG.	3.14	100	0.005	N/A	0.656
02J-F6	360	DEG.	3.14	100	0.005	N/A	0.653
02K-S3	360	DEG.	3.14	100	0.005	N/A	0.669
02K-S4	360	DEG.	3.14	100	0.005	N/A	0.678
02K-F6	360	DEG.	3.14	100	0.005	N/A	0.608
02L-S3	360	DEG.	3.14	100	0.005	0.76	0.669
02L-S4	360	DEG.	3.14	100	0.005	N/A	0.683
02M-S3	360	DEG.	3.14	100	0.005	N/A	0.667
02M-S4	360	DEG.	3.14	100	0.005	N/A	0.689
02M-F7	360	DEG.	3.14	100	0.005	N/A	0.575
02B-S9	360	DEG.	3.14	100	0.005	N/A	1.302
02AD-S6	360	DEG.	3.14	100	0.005	N/A	1.437
02AD-F12	360	DEG.	3.14	100	0.005	N/A	1.382
02AS-S4	360	DEG.	3.14	100	0.005	N/A	1.430
02AS-S9	360	DEG.	3.14	100	0.005	N/A	1.368
02AS-S12	360	DEG.	3.14	100	0.005	N/A	1.392
02AS-F14	360	DEG.	3.14	100	0.005	N/A	1.365
02BD-S6	360	DEG.	3.14	100	0.005	N/A	1.425
02BD-F8	360	DEG.	3.14	100	0.005	N/A	1.460
02BS-F2	360	DEG.	3.14	100	0.005	N/A	1.398
02BS-S3	360	DEG.	3.14	100	0.005	0.52	1.423
02BS-F7	360	DEG.	3.14	100	0.005	N/A	1.255
02BS-S12	360	DEG.	3.14	100	0.005	N/A	1.422
10S-F1	360	DEG.	3.14	100	0.005	N/A	1.021
10S-F5	360	DEG.	3.14	100	0.005	N/A	1.026

NOTES:
(1) Half crack angle .
(2) Crack depth from inside surface as % of wall thickness.
(3) Balance-of-plant life fatigue allowance.
(4) Remaining ligament from outside surface.
(5) Flaw Depth = maximum of ($\%t_p + t_r + a_f$) or ($t - t_r + a_f$).
(6) Unflawed weld.

Table 5.1-3

QUAD CITIES UNIT 2
CIRCUMFERENTIALLY FLAWED OVERLAY-REPAIRED WELDS
PREDICTED VS. ALLOWABLE FLAW DEPTH RATIOS

WELD ID	FLR[1]	S_m[2]	APPLIED STRESS RATIO[3]	ALLOWABLE FDR[4]	PREDICTED FDR[5]	FDR CHECK[6]
02C-S3	1.0	16950	0.27	0.75	0.65	OK
02C-S4[7]	1.0	16950	0.29	0.75	0.67	OK
02C-F7	1.0	16950	0.26	0.75	0.63	OK
02D-S3	1.0	16950	0.29	0.75	0.70	OK
02D-F6	1.0	16950	0.37	0.75	0.65	OK
02E-S3	1.0	16950	0.28	0.75	0.66	OK
02E-F6A	1.0	16950	0.35	0.75	0.68	OK
02F-S3	1.0	16950	0.29	0.75	0.69	OK
02F-F6	1.0	16950	0.40	0.73	0.63	OK
02G-S3	1.0	16950	0.31	0.75	0.69	OK
02G-S4	1.0	16950	0.30	0.75	0.74	OK
02H-S3	1.0	16950	0.28	0.75	0.68	OK
02H-S4[7]	1.0	16950	0.30	0.75	0.69	OK
02J-S3	1.0	16950	0.24	0.75	0.69	OK
02J-S4	1.0	16950	0.28	0.75	0.70	OK
02J-F6	1.0	16950	0.33	0.75	0.64	OK
02K-S3	1.0	16950	0.30	0.75	0.70	OK
02K-S4	1.0	16950	0.27	0.75	0.69	OK
02K-F6	1.0	16950	0.40	0.73	0.66	OK
02L-S3	1.0	16950	0.30	0.75	0.67	OK
02L-S4	1.0	16950	0.29	0.75	0.68	OK
02M-S3	1.0	16950	0.28	0.75	0.63	OK
02M-S4	1.0	16950	0.29	0.75	0.71	OK
02M-F7	1.0	16950	0.35	0.75	0.53	OK
02B-S9	1.0	16950	0.24	0.75	(8)	(8)
02AD-S6	1.0	16950	0.31	0.75	0.74	OK
02AD-F12	1.0	16950	0.37	0.75	0.71	OK
02AS-S4	1.0	16950	0.29	0.75	0.74	OK
02AS-S9	1.0	16950	0.31	0.75	0.74	OK
02AS-S12	1.0	16950	0.31	0.75	0.72	OK
02AS-F14	1.0	16950	0.33	0.75	0.71	OK
02BD-S6	1.0	16950	0.31	0.75	0.73	OK
02BD-F8	1.0	16950	0.30	0.75	0.73	OK
02BS-F2	1.0	16950	0.29	0.75	0.74	OK
02BS-S3	1.0	16950	0.29	0.75	0.75	OK
02BS-F7	1.0	16950	0.33	0.75	0.72	OK
02BS-S12	1.0	16950	0.29	0.75	0.73	OK
10S-F1	1.0	16950	0.40	0.73	0.68	OK
10S-F5	1.0	16950	0.26	0.75	0.66	OK

NOTES:
(1) FLR = flaw length ratio = a/π; a from Table 5.1-2.
(2) Allowable design stress intensity @550°F per ASME Section III Appendices Table I-1.2 for Type 304 Material.
(3) Applied Stress Ratio = (total overlay stress/S_m) x (t_{pd}/t).
(4) Allowable flaw depth ratio from Table 3.1-1.
(5) Predicted flaw depth ratio = a/t; "a" from Table 5.1-2.
(6) If predicted FDR < allowable FDR, weld is "OK".
(7) Unflawed weld.
(8) Detailed discussion of weld 02B-S9 may be found in

Table 5.1-4

QUAD CITIES UNIT 2
AXIALLY FLAWED OVERLAY-REPAIRED WELDS
PIPE AND WELD OVERLAY REPAIR GEOMETRY DETAILS

WELD ID	NOMINAL PIPE OD[1] (inches)	MAXIMUM PIPE WALL THK. (t_p) (inches)	MIN. TOTAL OVERLAY THK. (t_o) (inches)	LOW FN 1ST LAYER THK. (t_1)[2] (inches)	TOTAL THK. (t)[3] (inches)
02C-S3	12.750	0.653	0.355	N/A	1.008
02C-S4[4]	12.750	0.690	0.343	N/A	1.033
02C-F7	12.750	0.684	0.406	N/A	1.090
02D-S3	12.750	0.669	0.293	N/A	0.962
02D-F6	12.750	0.595	0.329	N/A	0.924
02E-S3	12.750	0.656	0.351	N/A	1.007
02E-F6A	12.750	0.653	0.314	N/A	0.967
02F-S3	12.750	0.661	0.303	N/A	0.964
02F-F6	12.750	0.590	0.355	N/A	0.945
02G-S3	12.750	0.662	0.307	N/A	0.969
02G-S4	12.750	0.711	0.253	N/A	0.964
02H-S3	12.750	0.684	0.326	N/A	1.010
02H-S4[4]	12.750	0.680	0.313	N/A	0.993
02J-S3	12.750	0.826	0.378	N/A	1.204
02J-S4	12.750	0.651	0.280	N/A	0.931
02J-F6	12.750	0.648	0.372	N/A	1.020
02K-S3	12.750	0.664	0.298	N/A	0.962
02K-S4	12.750	0.673	0.309	N/A	0.982
02K-F6	12.750	0.603	0.316	N/A	0.919
02L-S3	12.750	0.664	0.333	N/A	0.997
02L-S4	12.750	0.678	0.323	N/A	1.001
02M-S3	12.750	0.662	0.404	N/A	1.066
02M-S4	12.750	0.684	0.291	N/A	0.975
02M-F7	12.750	0.570	0.512	N/A	1.082
02B-S9	22.000	1.184	0.514	0.113	1.698
02AD-S6	28.000	1.432	0.497	N/A	1.929
02AD-F12	28.000	1.377	0.575	N/A	1.952
02AS-S4	28.000	1.425	0.499	N/A	1.924
02AS-S9	28.000	1.363	0.488	N/A	1.851
02AS-S12	28.000	1.387	0.557	N/A	1.944
02AS-F14	28.000	1.360	0.570	N/A	1.930
02BD-S6	28.000	1.420	0.530	N/A	1.950
02BD-F8	28.000	1.455	0.540	N/A	1.995
02BS-F2	28.000	1.393	0.508	N/A	1.901
02BS-S3	28.000	1.418	0.492	N/A	1.910
02BS-F7	28.000	1.250	0.484	N/A	1.734
02BS-S12	28.000	1.417	0.525	N/A	1.942
10S-F1	20.000	1.016	0.491	N/A	1.507
10S-F5	20.000	1.021	0.543	N/A	1.564

NOTES:
(1) OD = outside diameter.
(2) Low ferrite number (FN) first layer thickness.
(3) Total thickness = $t_p + t_o$.
(4) Unflawed welds.
(5) All thickness dimensions are as-built dimensions.

Table 5.1-5

QUAD CITIES UNIT 2
AXIALLY FLAWED OVERLAY-REPAIRED WELDS
FLAW GEOMETRY DETAILS

WELD ID	$L^{(1)}$ (inches)	$L_s^{(2)}$ (inches)	$t_s^{(3)}$ (inches)	$a_f^{(4)}$ (inches)	$t_o^{(5)}$ (inches)
02C-S3	0.39	0.98	0.41	0.005	0.350
02C-S4[6]	N/A	1.04	N/A	0.005	0.338
02C-F7	0.43	1.03	0.52	0.005	0.401
02D-S3	0.30	1.00	0.30	0.005	0.288
02D-F6	0.39	0.89	0.50	0.005	0.324
02E-S3	0.41	0.98	0.38	0.005	0.346
02E-F6A	N/A	0.98	N/A	0.005	0.309
02F-S3	N/A	0.99	N/A	0.005	0.298
02F-F6	N/A	0.89	N/A	0.005	0.350
02G-S3	N/A	0.99	N/A	0.005	0.302
02G-S4	0.25	1.07	0.43	0.005	0.248
02H-S3	0.31	1.03	0.65	0.005	0.321
02H-S4[6]	N/A	1.02	N/A	0.005	0.308
02J-S3	0.50	1.24	0.47	0.005	0.373
02J-S4	0.80	0.98	0.38	0.005	0.275
02J-F6	0.51	0.97	0.42	0.005	0.367
02K-S3	0.39	1.00	0.38	0.005	0.293
02K-S4	0.61	1.01	0.35	0.005	0.304
02K-F6	0.65	0.90	0.38	0.005	0.311
02L-S3	0.70	1.00	0.44	0.005	0.328
02L-S4	N/A	1.02	N/A	0.005	0.318
02M-S3	0.60	0.99	0.42	0.005	0.399
02M-S4	N/A	1.03	N/A	0.005	0.286
02M-F7	N/A	0.86	N/A	0.005	0.507
02B-S9	N/A	1.78	N/A	0.005	0.396
02AD-S6	N/A	2.15	N/A	0.005	0.492
02AD-F12	N/A	2.07	N/A	0.005	0.570
02AS-S4	N/A	2.14	N/A	0.005	0.494
02AS-S9	N/A	2.04	N/A	0.005	0.483
02AS-S12	N/A	2.08	N/A	0.005	0.552
02AS-F14	N/A	2.04	N/A	0.005	0.565
02BD-S6	N/A	2.13	N/A	0.005	0.525
02BD-F8	N/A	2.18	N/A	0.005	0.535
02BS-F2	N/A	2.09	N/A	0.005	0.503
02BS-S3	N/A	2.13	N/A	0.005	0.487
02BS-F7	N/A	1.88	N/A	0.005	0.479
02BS-S12	N/A	2.13	N/A	0.005	0.520
10S-F1	N/A	1.52	N/A	0.005	0.486
10S-F5	N/A	1.53	N/A	0.005	0.538

NOTES:
(1) Maximum measured axial flaw length.
(2) Flaw evaluation length, taken as the greater of:
a. "L" or
b. 1.5*t per NUREG-0313, Rev. 2; t_s from Table 5.1-4.
(3) Minimum measured remaining ligament.
(4) Balance-of-plant life fatigue allowance.
(5) Minimum overlay thickness, taken as the lesser of:
a. $t_s - a_f$ or
b. $t_o - (t_f + a_f)$; t_o and t_f from Table 5.1-4.
(6) Unflawed weld.

Table 5.1-6

QUAD CITIES UNIT 2
AXIALLY FLAWED OVERLAY-REPAIRED WELDS
PREDICTED VS. ALLOWABLE REMAINING LIGAMENT THICKNESS

WELD ID	INT. PRESS. (P) (psi)	S_m [1] (psi)	APPLIED STRESS RATIO [2]	ACTUAL FLR [3]	ALLOW. FLR [4]	FLR CHECK [5]	t_s [6] (inches)	REQUIRED t_w [7] (inches)	t_w CHECK [8]
02C-S3	1250	16950	0.72	0.48	1.00	OK	0.350	0.125	OK
02C-S4 [9]	1250	16950	0.68	0.49	1.00	OK	0.338	0.125	OK
02C-F7	1250	16950	0.69	0.49	1.00	OK	0.401	0.125	OK
02D-S3	1250	16950	0.70	0.49	1.00	OK	0.288	0.125	OK
02D-F6	1250	16950	0.79	0.46	1.00	OK	0.324	0.125	OK
02E-S3	1250	16950	0.72	0.48	1.00	OK	0.346	0.125	OK
02E-F6A	1250	16950	0.72	0.48	1.00	OK	0.309	0.125	OK
02F-S3	1250	16950	0.71	0.48	1.00	OK	0.298	0.125	OK
02F-F6	1250	16950	0.80	0.46	1.00	OK	0.350	0.125	OK
02G-S3	1250	16950	0.71	0.48	1.00	OK	0.302	0.125	OK
02G-S4	1250	16950	0.66	0.50	1.00	OK	0.248	0.125	OK
02H-S3	1250	16950	0.69	0.49	1.00	OK	0.321	0.125	OK
02H-S4 [9]	1250	16950	0.69	0.49	1.00	OK	0.308	0.125	OK
02J-S3	1250	16950	0.57	0.54	1.00	OK	0.373	0.125	OK
02J-S4	1250	16950	0.72	0.48	1.00	OK	0.275	0.125	OK
02J-F6	1250	16950	0.73	0.48	1.00	OK	0.367	0.125	OK
02K-S3	1250	16950	0.71	0.48	1.00	OK	0.293	0.125	OK
02K-S4	1250	16950	0.70	0.49	1.00	OK	0.304	0.125	OK
02K-F6	1250	16950	0.78	0.46	1.00	OK	0.311	0.125	OK
02L-S3	1250	16950	0.71	0.48	1.00	OK	0.328	0.125	OK
02L-S4	1250	16950	0.69	0.49	1.00	OK	0.318	0.125	OK
02M-S3	1250	16950	0.71	0.48	1.00	OK	0.399	0.125	OK
02M-S4	1250	16950	0.69	0.49	1.00	OK	0.286	0.125	OK
02M-F7	1250	16950	0.82	0.45	1.00	OK	0.507	0.125	OK
02B-S9	1250	16950	0.69	0.49	1.00	OK	0.396	0.125	OK
02AD-S6	1250	16950	0.72	0.48	1.00	OK	0.492	0.125	OK
02AD-F12	1250	16950	0.75	0.47	1.00	OK	0.570	0.125	OK
02AS-S4	1250	16950	0.72	0.48	1.00	OK	0.494	0.125	OK
02AS-S9	1250	16950	0.76	0.47	1.00	OK	0.483	0.125	OK
02AS-S12	1250	16950	0.74	0.47	1.00	OK	0.552	0.125	OK
02AS-F14	1250	16950	0.76	0.47	1.00	OK	0.565	0.125	OK
02BD-S6	1250	16950	0.73	0.48	1.00	OK	0.525	0.125	OK
02BD-F8	1250	16950	0.71	0.48	1.00	OK	0.535	0.125	OK
02BS-F2	1250	16950	0.74	0.47	1.00	OK	0.503	0.125	OK
02BS-S3	1250	16950	0.73	0.48	1.00	OK	0.487	0.125	OK
02BS-F7	1250	16950	0.83	0.45	1.00	OK	0.479	0.125	OK
02BS-S12	1250	16950	0.73	0.48	1.00	OK	0.520	0.125	OK
10S-F1	1250	16950	0.73	0.48	1.00	OK	0.486	0.125	OK
10S-F5	1250	16950	0.72	0.48	1.00	OK	0.538	0.125	OK

NOTES:
(1) Allowable design stress intensity @550°F per ASME Section III Appendices Table I-1.2 for Type 304 material.
(2) Applied Stress Ratio = (P*OD) / (2xt_pxSm); OD and t_p from Table 5.1-4.
(3) Flaw Length Ratio = $L_e/\sqrt{0.5*OD*t_p}$; L_e from Table 5.1-5.
(4) Allowable FLR from Table 3.1-2.
(5) If actual FLR < allowable FLR, "OK".
(6) Minimum end-of-evaluation period (balance-of-plant life) overlay thickness; from Table 5.1-5.
(7) Minimum required Leakage Barrier overlay thickness; from Table 3.1-2.
(8) If $t_s > t_w$, "OK".
(9) Unflawed weld.

6.0 SUMMARY AND CONCLUSIONS

Ultrasonic (UT) examinations performed during the 1983 outage at Commonwealth Edison's Quad Cities Nuclear Power Station Unit 2 identified flaws judged to be IGSCC in the vicinity of twenty-three welds. Nineteen of these welds currently have "standard" weld overlay repairs, two are currently thought to be unflawed, and two have been replaced.

During the Quad Cities Unit 2 1985 outage, two new welds were identified as possibly containing IGSCC. These welds currently have "standard" weld overlay repairs.

UT examinations performed during the 1986 outage at Quad Cities Unit 2 identified flaws judged to be IGSCC in the vicinity of five additional welds. All of these welds currently have "standard" weld overlay repairs.

UT examinations performed during the 1988 outage at Quad Cities Unit 2 identified flaws judged to be IGSCC in the vicinity of twelve additional welds. Ten of these welds currently have "standard" weld overlay repairs and two have been replaced. Two other unflawed welds received "load leveling" overlays to reduce weld overlay axial shrinkage stresses at other unflawed weld locations in the RR system.

UT examinations performed during the 1990 outage at Quad Cities Unit 2 identified no new flaws judged to be IGSCC. One weld thought to have IGSCC flaw growth into the overlay repair was shown through the use of a boat sample to have IGSCC only up to the pipe wall-to-weld overlay repair interface.

No volumetric ultrasonic examinations of the Reactor Recirculation and Shutdown Cooling system weldments were performed during the 1992 outage at Quad Cities Unit 2.

Ultrasonic (UT) examinations performed during the 1993 outage at Quad Cities Unit 2 identified one flaw judged to have IGSCC. This flaw was repaired using the weld overlay technique.

Evaluations presented in this report for the thirty-seven Quad Cities Unit 2 welds believed to currently contain IGSCC demonstrate that the applied stress levels are acceptable for all design conditions. The analyses performed in the evaluation demonstrate that all the flawed welds having "standard" weld overlay repairs are acceptable for the balance-of-plant life per the requirements of NUREG-0313 (Reference 6) and can be placed in IGSCC Inspection Category "E".

Appendix C presents the sustained stress vs. allowable stress ratios for all unflawed and unrepaired IGSCC-susceptible welds outside of NUREG-0313 ISI Inspection Category "A".

7.0 REFERENCES

1. NUTECH Document No. COM-75-002, "Evaluation and Disposition of IGSCC Flaws at Quad Cities Nuclear Power Station Unit 2", Revision 1, March 1984.

2. NUTECH Document No. CEC-20-013, "Evaluation and Disposition of Flaws at Quad Cities Nuclear Power Plant Unit 2", Revision 1, July 1985.

3. NUTECH Document No. CEC-73-203, "Evaluation and Disposition of Flaws at Quad Cities Nuclear Power Plant Unit 2 (1986 Outage)", Revision 0, January 1987.

4. Structural Integrity Associates (SIA) Report No. SIR-88-018, Vol. 1 (Rev. 1) & Vol. 2 (Rev. 0), "Design Report for Recirculation and Reactor Water Clean-Up System Evaluations and Repairs Performed During the 1988 Refueling Outage at the Quad Cities Nuclear Power Plant, Unit 2", May/June 1988.

5. NUTECH Document No. XCE-42-252, "Evaluation and Disposition of IGSCC-Susceptible Weldments At Quad Cities Nuclear Power Station Unit 2 1990 Outage", Revision 2, September 1991.

6. NRC Document No. NUREG-0313, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping", Revision 2.

7. NUTECH Drawing No. M-3113, "Inservice Inspection Isometric - Recirculation System - Quad Cities Unit 2;" Sheets 1-2, Revision B; Sheet 3, Revision C; Sheet 4, Revision A.

8. Kulat, S.D., Pitcairn, D.R., and Sobon, L.J., "Experimental Verification of Analytically Determined Weld Overlay Residual Stress Distributions", Transactions of the 8th International Conference on Structural Mechanics in Reactor Technology (SMiRT), Paper D2/1, Brussels, Belgium, August 19-23, 1985.

9. EPRI Document No. NP-2423-LD, "Stress Corrosion Cracking of Type-304 Stainless Steel in High-Purity Water: A Compilation of Crack Growth Rates", June 1982.

10. ASME Boiler and Pressure Vessel Code (BPVC) Section XI, 1986 Edition with Addenda through 1989.

11. NUTECH Document No. COM-76-001, "Weld Overlay Design Criteria for Axial Cracks", Revision 0, March 1984.

12. NRC Generic Letter 88-01, Subject: NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping, January 25, 1988, with Supplement 1, February 4, 1992.

13. ASME Boiler and Pressure Vessel Code (BPVC) Section III, 1986 Edition with Addenda through 1989.

14. ABB Impell Letter No. 0591-417-114, dated April 19, 1991 (for Reactor Recirculation and Shutdown Cooling systems inside drywell).

15. ABB Impell Letter No. 0591-417-124, dated May 15, 1991 (for Reactor Recirculation and Shutdown Cooling systems inside drywell).

16. Sargent & Lundy Letter dated June 25, 1991, Project No. 8827-97 (for RHR system).

17. Sargent & Lundy Letter dated July 22, 1991, Project No. 8827-96/97 (for RHR system).

18. NUTECH Analysis No. 28.0202.0500 (dated September 29, 1982) and NUTECH Document No. XCE-09-100 (QC2.05), Revision 0 (for Shutdown Cooling System outside drywell).

19. NUTECH Document No. COM-0710-06, dated August 21, 1980 (for Core Spray system).

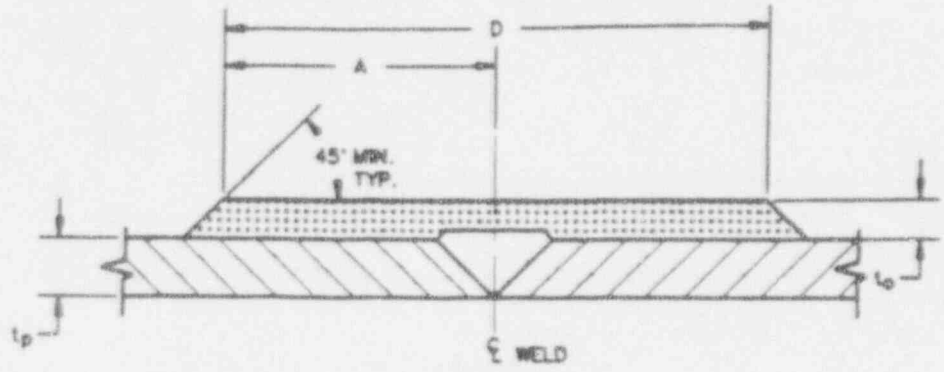
20. Pacific Nuclear Computer Program PISTAR, Version 4.1.0 User's Manual, PSD-89-005, Revision 1, NUTECH Corporate File No. QASJO.SOFT.2.036.4.0.0.2.

Appendix A

QUAD CITIES UNIT 2
COMPARISON AND DESCRIPTION OF FLAWED WELDMENTS
WITH AS-BUILT OVERLAY DIMENSIONS

WELD NO.	PAGE NO.
REACTOR RECIRCULATION: 12" NPS	
02C-S3	A.2
02C-S4	A.3
02C-F7	A.4
02D-S3	A.5
02D-F6	A.6
02E-S3	A.7
02E-F6A	A.8
02F-S3	A.9
02F-F6	A.10
02G-S3	A.11
02G-S4	A.12
02H-S3	A.13
02H-S4	A.14
02J-S3	A.15
02J-S4	A.16
02J-F6	A.17
02K-S3	A.18
02K-S4	A.19
02K-F6	A.20
02L-S3	A.21
02L-S4	A.22
02M-S3	A.23
02M-S4	A.24
02M-F7	A.25

WELD NO.	PAGE NO.
REACTOR RECIRCULATION: 22" NPS	
02A-S10	A.26
02B-S9	A.27
REACTOR RECIRCULATION: 28" NPS	
02AD-S6	A.28
02AD-F12	A.29
02AS-S4	A.30
02AS-S6	A.31
02AS-S9	A.32
02AS-S12	A.33
02AS-F14	A.34
02BD-S6	A.35
02BD-F8	A.36
02BS-F2	A.37
02BS-S3	A.38
02BS-F7	A.39
02BS-S12	A.40
02BS-F14	A.41
SHUTDOWN COOLING: 20" NPS	
10S-F1	A.42
10S-F5	A.43
REACTOR WATER CLEAN-UP: 6" NPS	
12S-S24	A.44
12S-F26R	A.45
12S-S27	A.46



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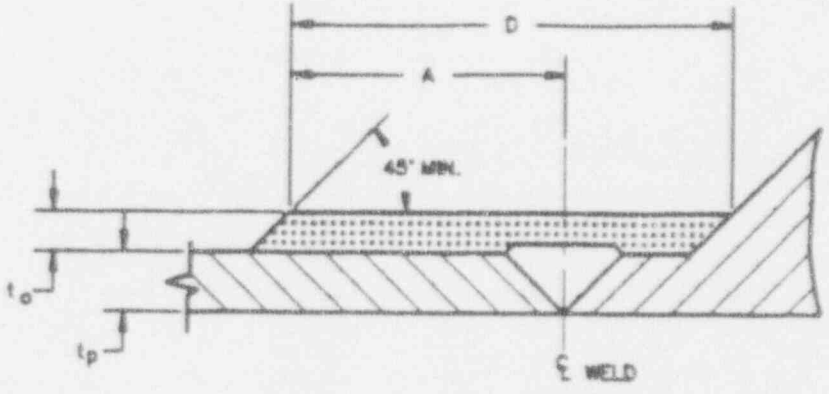

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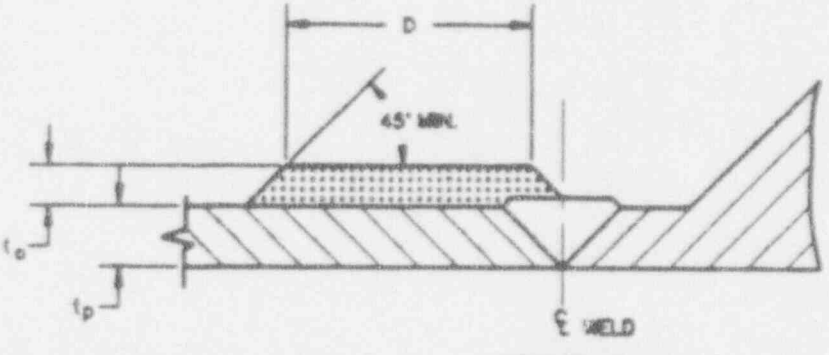


TYPE 3

WELD OVERLAY TYPES

PIPE SIZE: 12.75"

DIM. "D": 4.4"

AXIAL SHR.: 0.203"

WELD NO.: [illegible]

WOR TYPE: [illegible]

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.653"	0.561"
OVERLAY THK. (to):	0.391"	0.355"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.2"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	---------- NO REPORTABLE INDICATIONS ----------					IHSI TREATED
1985	---------- NO REPORTABLE INDICATIONS ----------					
1986	BEFORE OVERLAY REPAIR:					
	1-1/4"	29%	N/A	CIRC.	ELBOW SIDE	
	---	36%	N/A	AXIAL	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.75"	N/A	0.36"	AXIAL	ELBOW SIDE	
	0.60"	N/A	0.34"	AXIAL	ELBOW SIDE	
1988	---------- NOT INSPECTED ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	0.39"	N/A	0.47"	AXIAL	PIPE SIDE	
	0.28"	N/A	0.41"	AXIAL	ELBOW SIDE	
	0.34"	N/A	0.42"	AXIAL	PIPE SIDE	
	0.22"	N/A	0.43"	AXIAL	ELBOW SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.5"

AXIAL SHR.: 0.254"

WELD NO.: 22C-84

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	0.605"	0.690"
OVERLAY THK. (to):	0.365"	0.343"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	2.25"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1988	---------- NO REPORTABLE INDICATIONS ----------					"STANDARD" OVERLAY APPLIED (FOR LOAD LEVELING)
1990	---------- NOT INSPECTED ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 3.874"

AXIAL SHR.: 0.197"

WELD NO.: 020-F7

WOR TYPE: 2

	UPSTREAM	DNSTREAM
CONFIGURATION:	SWEEPOLET	PIPE
PIPE WALL THK. (tp):	0.684"	0.630"
OVERLAY THK. (to):	0.407"	0.406"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.3"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1993	BEFORE OVERLAY REPAIR:					
	5"	21%	N/A	CIRC.	PIPE SIDE	
	0.3"	72%	N/A	AXIAL	PIPE SIDE	
	AFTER OVERLAY REPAIR:					
	0.43"	N/A	0.58"	AXIAL	PIPE SIDE	"STANDARD" OVERLAY REPAIRED
	0.24"	N/A	0.52"	AXIAL	PIPE SIDE	
	0.41"	N/A	0.54"	AXIAL	PIPE SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.8"

AXIAL SHR.: 0.230"

WELD NO.: 02D-S2

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.669"	0.600"
OVERLAY THK. (to):	0.316"	0.293"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.6"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	1/2"	25%	N/A	CIRC.	PIPE SIDE	IHSI TREATED
1985	1/2"	26-28%	N/A	CIRC.	PIPE SIDE	
1986	0.6"	17%	N/A	CIRC.	PIPE SIDE	
1988	BEFORE OVERLAY REPAIR:					
	1.5"	0.24"	N/A	CIRC.	PIPE SIDE	
	2"	0.15"	N/A	CIRC.	ELBOW SIDE	
	1"	0.15"	N/A	CIRC.	ELBOW SIDE	
	1"	0.15"	N/A	CIRC.	ELBOW SIDE	
	0.9" MAX.	0.24" MAX	N/A	AXIAL (3)	PIPE SIDE	
	0.8" MAX.	0.22" MAX	N/A	AXIAL (3)	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.5"	N/A	0.38"	AXIAL	PIPE SIDE	
	0.5"	N/A	0.52"	AXIAL	ELBOW SIDE	
	0.8"	N/A	0.39"	AXIAL	ELBOW SIDE	
	0.7"	N/A	0.29"	AXIAL	ELBOW SIDE	
1990	0.20"	N/A	0.36"	AXIAL	PIPE SIDE	
	0.30"	N/A	0.39"	AXIAL	ELBOW SIDE	
	0.25"	N/A	0.30"	AXIAL	ELBOW SIDE	
1992	---------- NOT INSPECTED ----------					
1993	0.30"	N/A	0.38"	AXIAL	ELBOW SIDE	
	0.19"	N/A	0.30"	AXIAL	ELBOW SIDE	
	0.21"	N/A	0.36"	AXIAL	ELBOW SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.0"

AXIAL SHR.: 0.106"

WELD NO.: 32D-F8

WOR TYPE: 2

	UPSTREAM	DNSTREAM
CONFIGURATION:	SWEEPOLET	PIPE
PIPE WALL THK. (tp):	N/A	0.595"
OVERLAY THK. (to):	N/A	0.329"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.0"

OUTAGE	LENGTH	DEPTH	REMAINING REINFORCEMENT	ORIENT.	LOCATION	COMMENT
1983	8"	80%	N/A	CIRC.	PIPE SIDE	"ENGINEERED" OVERLAY REPAIRED
1985	---------- NOT INSPECTED ----------					
1986	0.4"	N/A	0.62"	AXIAL	PIPE SIDE	BUILT-UP TO "STANDARD" OVERLAY
	0.5"	N/A	0.62"	AXIAL	PIPE SIDE	
1988	0.4"	N/A	0.61"	AXIAL	PIPE SIDE	
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	0.39"	N/A	0.50"	AXIAL	SWEEPOLET	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.7"

AXIAL SHR.: 0.215"

WELD NO.: 32E-83

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.656"	0.584"
OVERLAY THK. (to):	0.351"	0.366"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.4"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	---	0.14"	N/A	AXIAL	PIPE SIDE	
	---	0.11"	N/A	AXIAL	PIPE SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.50"	N/A	0.42"	AXIAL	PIPE SIDE	
	0.50"	N/A	0.62"	AXIAL	PIPE SIDE	
1990	0.30"	N/A	0.42"	AXIAL	---	
	0.40"	N/A	0.37"	AXIAL	---	
1992	---------- NOT INSPECTED ----------					
1993	0.49"	N/A	0.43"	AXIAL	ELBOW SIDE	
	0.37"	N/A	0.38"	AXIAL	ELBOW SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75" WELD NO.: 32E-F6A

DIM. "D": 4.5" WOR TYPE: 1

AXIAL SHR.: 0.287"

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	PIPE
PIPE WALL THK. (tp):	0.653"	0.601"
OVERLAY THK. (to):	0.314"	0.373"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.25"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	---------- NO REPORTABLE INDICATIONS ----------					IHSI TREATED
1985	BEFORE OVERLAY REPAIR:					"ENGINEERED" OVERLAY REPAIRED
	1"	18%	N/A	CIRC.	UPSTREAM	
	w/ 1/4"	11%	N/A	AXIAL		
	1/2"	14%	N/A	CIRC.	UPSTREAM	
	w/ 0.2"	13%	N/A	AXIAL		
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1988	---------- NOT INSPECTED ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75" | WELD NO.: 02F-63

DIM. "D": 4.6" | WOR TYPE: 1

AXIAL SHR.: 0.184"

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.651"	0.661"
OVERLAY THK. (to):	0.364"	0.303"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.3"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	0.5"	0.28"	N/A	CIRC.	PIPE SIDE	
	1.0"	0.13"	N/A	CIRC.	PIPE SIDE	
	0.9"	0.22"	N/A	AXIAL	PIPE SIDE	
	1.0" MAX.	0.13" MAX	N/A	AXIAL (4)	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.10"	N/A	0.72"	CIRC.	PIPE SIDE	
	0.10"	N/A	0.61"	CIRC.	PIPE SIDE	
1990	6.5"	N/A	0.71"	CIRC.	PIPE SIDE	
	0.30"	N/A	0.63"	CIRC.	PIPE SIDE	
1992	---------- NOT INSPECTED ----------					
1993	20.1"	N/A	0.61"	CIRC.	---	
	7.1"	N/A	0.57"	CIRC.	---	
	5.4"	N/A	0.66"	CIRC.	---	
	2.9"	N/A	0.67"	CIRC.	---	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.3"

AXIAL SHR.: 0.254"

WELD NO.: 02F-F6

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	PIPE
PIPE WALL THK. (tp):	0.590"	0.561"
OVERLAY THK. (to):	0.355"	0.392"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.1"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	360 DEG.	80%	N/A	CIRC.	PIPE SIDE	"ENGINEERED" OVERLAY REPAIRED
1985	---------- NOT INSPECTED ----------					
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1988	---------- NO REPORTABLE INDICATIONS ----------					
1990	---------- NOT INSPECTED ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.4"

AXIAL SHR.: 0.280"

WELD NO.: 02B-83

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.662"	0.591"
OVERLAY THK. (to):	0.307"	0.313"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.25"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	2-1/4"	32%	N/A	CIRC.	PIPE SIDE	"ENGINEERED" OVERLAY REPAIRED
1985	---------- NOT INSPECTED ----------					
1986	26" (intermit.)	N/A	0.58"	CIRC.	ELBOW SIDE	BUILT-UP TO "STANDARD" OVERLAY
1988	---------- NOT INSPECTED ----------					
1990	9.5"	N/A	0.66"	CIRC.	---	
	3.0"	N/A	0.60"	CIRC.	---	
1992	---------- NOT INSPECTED ----------					
1993	17.4"	N/A	0.66"	CIRC.	---	
	5.0"	N/A	0.80"	CIRC.	---	
	6.4"	N/A	0.65"	CIRC.	---	

(QC2FLAW.wk1/a11)

PIPE SIZE: 12.75"

DIM. "D": 4.6"

AXIAL SHR.: 0.221"

WELD NO.: 020-54

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	0.603"	0.711"
OVERLAY THK. (to):	0.319"	0.253"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	2.3"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	---	0.17"	N/A	AXIAL	PIPE SIDE	
	---	0.32"	N/A	AXIAL	PIPE SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.10"	N/A	0.44"	AXIAL	PIPE SIDE	
	0.10"	N/A	0.45"	AXIAL	PIPE SIDE	
1990	0.10"	N/A	0.44"	AXIAL	---	
1992	---------- NOT INSPECTED ----------					
1993	0.25"	N/A	0.43"	AXIAL	ELBOW SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.5"

AXIAL SHR.: 0.318"

WELD NO.: 02H-63

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.684"	0.601"
OVERLAY THK. (to):	0.326"	0.346"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.25"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	0.5"	0.20"	N/A	AXIAL	PIPE SIDE	
	0.5"	0.30"	N/A	AXIAL	PIPE SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	---------- NO REPORTABLE INDICATIONS ----------					
1990	0.30"	N/A	0.67"	AXIAL	---	
1992	----------	----- NOT INSPECTED ----------				
1993	0.31"	N/A	0.65"	AXIAL	ELBOW SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.5"

AXIAL SHR.: 0.229"

WELD NO.: 12H-54

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	0.622"	0.680"
OVERLAY THK. (to):	0.338"	0.313"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	2.3"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	---------- NO REPORTABLE INDICATIONS ----------					"STANDARD" OVERLAY APPLIED (FOR LOAD LEVELING)
1992	---------- NOT INSPECTED ----------					
1993	---------- NOT INSPECTED ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.6"

AXIAL SHR.: 0.201"

WELD NO.: 02J-S3

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.826"	0.595"
OVERLAY THK. (to):	0.378"	0.482"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.3"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	0.72"	0.10"	N/A	AXIAL	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.80"	N/A	0.32"	AXIAL	---	
	0.50"	N/A	0.32"	AXIAL	---	
1990	AFTER BOAT SAMPLE EXTRACTION:					BOAT SAMPLE EXTRACTED, MANUALLY REPAIRED, AND ONE ADDITIONAL
	0.50"	N/A	0.47"	AXIAL	---	MACHINE GTAW LAYER ADDED
1992	---------- NOT INSPECTED ----------					
1993	0.50"	N/A	0.47"	AXIAL	ELBOW SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.9"

AXIAL SHR.: 0.197"

WELD NO.: 021-84

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	0.649"	0.651"
OVERLAY THK. (to):	0.280"	0.414"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	2.5"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	2.5"	0.15"	N/A	CIRC.	PIPE SIDE	
	w/ 0.25"	0.15"	N/A	AXIAL		
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.80"	N/A	0.48"	AXIAL	PIPE SIDE	
	0.30"	N/A	0.47"	AXIAL	ELBOW SIDE	
1990	0.85"	N/A	0.45"	AXIAL	---	
	0.75"	N/A	0.35"	AXIAL	---	
	0.30"	N/A	0.39"	AXIAL	---	
	0.50"	N/A	0.58"	AXIAL	---	
1992	---------- NOT INSPECTED ----------					
1993	0.80"	N/A	0.48"	AXIAL	PIPE SIDE	
	0.70"	N/A	0.40"	AXIAL	PIPE SIDE	
	0.30"	N/A	0.38"	AXIAL	PIPE SIDE	
	0.50"	N/A	0.47"	AXIAL	ELBOW SIDE	

(QC2FLAW.wk1/s11)

PIPE SIZE: 12.75"

DIM. "D": 3.8"

AXIAL SHR.: 0.263"

WELD NO.: 022-FA

WOR TYPE: 2

	UPSTREAM	DNSTREAM
CONFIGURATION:	SWEEPOLET	PIPE
PIPE WALL THK. (tp):	N/A	0.648"
OVERLAY THK. (to):	N/A	0.372"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.0"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	15"	15%	N/A	CIRC.	PIPE SIDE	"ENGINEERED" OVERLAY REPAIRED
1985	---------- NOT INSPECTED ----------					
1986	------- NO INDICATIONS IN WELD OVERLAY REPAIR -------					BUILT-UP TO "STANDARD" OVERLAY
1988	0.50"	N/A	0.44"	AXIAL	PIPE SIDE	
1990	0.35"	N/A	0.45"	AXIAL	PIPE SIDE	
1992	---------- NOT INSPECTED ----------					
1993	0.51"	N/A	0.42"	AXIAL	SWEEP. SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.0"

AXIAL SHR.: 0.168"

WELD NO.: 02R-53

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.664"	0.587"
OVERLAY THK. (to):	0.298"	0.316"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.0"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	---------- NO REPORTABLE INDICATIONS ----------					IHSI TREATED
1985	---------- NO REPORTABLE INDICATIONS ----------					
1986	BEFORE OVERLAY REPAIR:					
	PINHOLE LEAKING	N/A		AXIAL	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	1.0" MAX.	N/A	0.40" MIN.	AXIAL (3)	ELBOW SIDE	
1988	---------- NOT INSPECTED ----------					
1990	0.40" MAX	N/A	0.38" MIN.	AXIAL (4)	---	
1992	---------- NOT INSPECTED ----------					
1993	0.39"	N/A	0.39"	AXIAL	PIPE SIDE	
	0.31"	N/A	0.38"	AXIAL	PIPE SIDE	
	0.30"	N/A	0.38"	AXIAL	ELBOW SIDE	
	0.35"	N/A	0.44"	AXIAL	ELBOW SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.1"

AXIAL SHR.: 0.290"

WELD NO.: 02R-S4

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	0.600"	0.673"
OVERLAY THK. (to):	0.309"	0.329"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	2.05"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	---------- NO REPORTABLE INDICATIONS ----------					IHSI TREATED
1985	---------- NO REPORTABLE INDICATIONS ----------					
1986	BEFORE OVERLAY REPAIR:					
	NOT GIVEN	0.15"	N/A	AXIAL	PIPE SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	3/8"	N/A	0.50"	AXIAL	PIPE SIDE	
	3/8"	N/A	0.51"	AXIAL	PIPE SIDE	
1988	---------- NOT INSPECTED ----------					
1990	0.70"	N/A	0.34"	AXIAL	PIPE SIDE	
	0.40"	N/A	0.36"	AXIAL	PIPE SIDE	
1992	---------- NOT INSPECTED ----------					
1993	0.61"	N/A	0.35"	AXIAL	PIPE SIDE	
	0.31"	N/A	0.37"	AXIAL	PIPE SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.1"

AXIAL SHR.: 0.169"

WELD NO.: 02R-F6

WOR TYPE: 2

	UPSTREAM	DNSTREAM
CONFIGURATION:	SWEEPOLET	PIPE
PIPE WALL THK. (tp):	N/A	0.603"
OVERLAY THK. (to):	N/A	0.316"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.5"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	0.4"	0.33"	N/A	CIRC.	PIPE SIDE	
	0.5"	0.30"	N/A	AXIAL	PIPE SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.60"	N/A	0.39"	AXIAL	PIPE SIDE	
1990	0.56"	N/A	0.35"	AXIAL	PIPE SIDE	
1992	---------- NOT INSPECTED ----------					
1993	0.65"	N/A	0.38"	AXIAL	SWEEP. SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.5"

AXIAL SHR.: 0.259"

WELD NO.: 02L-83

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.664"	0.601"
OVERLAY THK. (to):	0.333"	0.338"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.25"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	---	0.10"	N/A	AXIAL	ELBOW SIDE	
	SPOT	0.08"	N/A	AXIAL	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	---	---	---	---	---	
1990	0.50"	N/A	0.42"	AXIAL	---	
	0.50"	N/A	0.54"	AXIAL	---	
	0.60"	N/A	0.47"	AXIAL	---	
	0.65"	N/A	0.60"	AXIAL	---	
1992	---------- NOT INSPECTED ----------					
1993	0.40"	N/A	0.51"	AXIAL	PIPE SIDE	
	0.45"	N/A	0.44"	AXIAL	PIPE SIDE	
	0.50"	N/A	0.54"	AXIAL	PIPE SIDE	
	0.50"	N/A	0.46"	AXIAL	PIPE SIDE	
	0.70"	N/A	0.59"	AXIAL	PIPE SIDE	
	1.40"	N/A	0.76"	CIRC.	ELBOW SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.5"

AXIAL SHR.: 0.235"

WELD NO.: 02L-54

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	0.599"	0.678"
OVERLAY THK. (to):	0.346"	0.323"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.25"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983						IHSI TREATED
1988	BEFORE OVERLAY REPAIR:					
	0.3"	0.25"	N/A	AXIAL	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	---------- NO REPORTABLE INDICATIONS ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.5"

AXIAL SHR.: 0.253"

WELD NO.: 02M-63

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.662"	0.591"
OVERLAY THK. (to):	0.408"	0.404"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.25"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	1-1/2"	30%	N/A	CIRC.	ELBOW SIDE	IHSI TREATED
	1"	13%	N/A	CIRC.	PIPE SIDE	
1985	3-1/2"	50%	N/A	CIRC.	ELBOW SIDE	"ENGINEERED" OVERLAY REPAIRED
	2"	65%	N/A	CIRC.	PIPE SIDE	
	7/8"	70%	N/A	AXIAL	PIPE SIDE	
1986	0.6"	N/A	0.7"	CIRC.	ELBOW SIDE	BUILT-UP TO "STANDARD" OVERLAY
	0.20"	N/A	0.70"	AXIAL	PIPE SIDE	
	0.60"	N/A	0.60"	AXIAL	PIPE SIDE	
	0.45"	N/A	0.45"	AXIAL	PIPE SIDE	
	0.40"	N/A	0.45"	AXIAL	PIPE SIDE	
1988	0.6"	N/A	0.7"	CIRC.	ELBOW SIDE	
	0.20"	N/A	0.70"	AXIAL	PIPE SIDE	
	0.60"	N/A	0.60"	AXIAL	PIPE SIDE	
	0.45"	N/A	0.45"	AXIAL	PIPE SIDE	
	0.40"	N/A	0.45"	AXIAL	PIPE SIDE	
1990	0.50"	N/A	0.51"	AXIAL	PIPE SIDE	
	0.50"	N/A	0.45"	AXIAL	PIPE SIDE	
	0.45"	N/A	0.52"	AXIAL	PIPE SIDE	
	0.10"	N/A	0.40"	AXIAL	PIPE SIDE	
1992	---------- NOT INSPECTED ----------					
1993	0.40"	N/A	0.56"	AXIAL	PIPE SIDE	
	0.50"	N/A	0.42"	AXIAL	PIPE SIDE	
	0.60"	N/A	0.49"	AXIAL	PIPE SIDE	
	0.40"	N/A	0.70"	AXIAL	PIPE SIDE	
	0.50"	N/A	0.56"	AXIAL	PIPE SIDE	
	0.58"	N/A	0.55"	AXIAL	PIPE SIDE	
	0.50"	N/A	0.46"	AXIAL	PIPE SIDE	

(QC2FLAW.wk1/all)

PIPE SIZE: 12.75"

DIM. "D": 4.6"

AXIAL SHR.: 0.241"

WELD NO.: 02M-84

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	0.609"	0.684"
OVERLAY THK. (to):	0.291"	0.348"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	2.3"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	1/2"	9%	N/A	CIRC.	ELBOW SIDE	IHSI TREATED
1985	1/2"	15%	N/A	CIRC.	ELBOW SIDE	
1986	1/2"	12%	N/A	CIRC.	ELBOW SIDE	
1988	BEFORE OVERLAY REPAIR:					
	1.3"	0.1"	N/A	CIRC.	ELBOW SIDE	
	w/ 0.4"	0.1"	N/A	AXIAL	ELBOW SIDE	
	0.7"	0.1"	N/A	CIRC.	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	---------- NO REPORTABLE INDICATIONS ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE:	12.75"	WELD NO.:	02M-F7
DIM. "D":	3.8"	WOR TYPE:	2
AXIAL SHR.:	0.194"		

	UPSTREAM	DNSTREAM
CONFIGURATION:	SWEEPOLET	PIPE
PIPE WALL THK. (tp):	N/A	0.570"
OVERLAY THK. (to):	N/A	0.512"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.0"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	---------- 4-1/2" LONG LACK-OF-FUSION ----------					INSI TREATED
1985	7-1/2"	100%	N/A	CIRC.	SWEEP. SIDE	"ENGINEERED" OVERLAY REPAIRED
1986	0.5"	N/A	0.68"	CIRC.	PIPE SIDE	BUILT-UP TO "STANDARD" OVERLAY
1988	0.5"	N/A	0.68"	CIRC.	PIPE SIDE	
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 22"

DIM. "D": N/A

AXIAL SHR.: N/A

WELD NO.: 02A-S1.0*

WOR TYPE: N/A

* RENUMBERED 02A-F10R

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	END CAP
PIPE WALL THK. (tp):	1.07"	1.24"
OVERLAY THK. (to):	N/A	N/A
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	4"	26%	N/A	CIRC.	END CAP SIDE	IHSI TREATED
1985	4"	16%	N/A	CIRC.	END CAP SIDE	
1986	BEFORE OVERLAY REPAIR:					
	8.6" TOTA	26% MAX.	N/A	CIRC. (9)	END CAP SIDE	
	---	30% MAX.	N/A	AXIAL (29)	END CAP SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	0.8"	N/A	0.38"	CIRC.	END CAP SIDE	
	1.0" MAX.	N/A	0.35" MIN.	AXIAL (8)	END CAP SIDE	
1988	AFTER FABRICATION DEFECT REPAIRS:					1986 FAB. DEFECTS EXCAVATED
	0.6"	N/A	0.71"	AXIAL	END CAP SIDE	
	0.4"	N/A	0.76"	AXIAL	END CAP SIDE	
1990	AFTER REPLACEMENT:					END CAP REPLACED
	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 22"

DIM. "D": 5.0"

AXIAL SHR.: N/A

WELD NO.: 02B-SP

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	END CAP
PIPE WALL THK. (tp):	1.044"	1.184"
OVERLAY THK. (to):	0.601"	0.514"
LOW DELTA FERRITE FIRST LAYER THK.:	0.105"	0.113"
DIMENSION "A":	3.0"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	17" TOTAL	15% MAX.	N/A	CIRC.	END CAP SIDE	IHSI TREATED
1985	17" TOTAL	14% MAX.	N/A	CIRC.	END CAP SIDE	
1986	BEFORE OVERLAY REPAIR:					
	11.6" TOT	17% MAX.	N/A	CIRC. (10)	END CAP SIDE	
	NOT GIVEN	25% MAX.	N/A	AXIAL (15)	END CAP SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	2.5"	N/A	0.60"	CIRC.	END CAP SIDE	
	2.5"	N/A	0.56"	CIRC.	END CAP SIDE	
	1.0" MAX.	N/A	0.55" MIN.	AXIAL (6)	END CAP SIDE	
1988	2.5"	N/A	0.60"	CIRC.	END CAP SIDE	
	2.5"	N/A	0.56"	CIRC.	END CAP SIDE	
	1.0" MAX.	N/A	0.46" MIN.	AXIAL (8)	END CAP SIDE	
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 8.7"

AXIAL SHR.: 0.076"

WELD NO.: 02AD-56

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	1.432"	1.412"
OVERLAY THK. (to):	0.497"	0.510"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION 'A":	4.4"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	----------	ID GEOMETRY	----------			IHSI TREATED
1985	----------	NOT INSPECTED	----------			
1986	----------	ROOT GEOMETRY	----------			
1988	3"	7%	N/A	CIRC.	ELBOW SIDE	FLAWED PIPE EVALUATION PERFORMED
1990	----------	NO REPORTABLE INDICATIONS	----------			"STANDARD" OVERLAY REPAIRED
1992	----------	NOT INSPECTED	----------			
1993	----------	NO REPORTABLE INDICATIONS	----------			

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 7.3"

AXIAL SHR.: 0.005"

WELD NO.: [illegible]

WOR TYPE: 2

	UPSTREAM	DNSTREAM
CONFIGURATION:	PUMP	PIPE
PIPE WALL THK. (tp):	1.377"	1.357"
OVERLAY THK. (to):	0.762"	0.575"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	4.5"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	24" total	10%	N/A	CIRC.	PIPE SIDE	IHSI TREATED; FLAWED PIPE EVALUATION PERFORMED
1985	1"	16%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
1986	1"	17%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
1988	1"	17%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
1990	---------- NO REPORTABLE INDICATIONS ----------					"STANDARD" OVERLAY REPAIRED
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 8.5"

AXIAL SHR.: NOT GIVEN

WELD NO.: 12A8-84

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	1.425"	1.210"
OVERLAY THK. (to):	0.499"	0.504"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	4.25"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	27" TOTAL	13%	N/A	CIRC.	ELBOW SIDE	IHSI TREATED
	4"	11%	N/A	CIRC.	PIPE SIDE	
1985	58"	70% MAX.	N/A	CIRC.	ELBOW SIDE	"ENGINEERED" OVERLAY REPAIRED
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1988	---------- NO REPORTABLE INDICATIONS ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": N/A

AXIAL SHR.: N/A

WELD NO.: 02A5-S6

WOR TYPE: N/A

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	PIPE
PIPE WALL THK. (tp):	1.25"	1.35"
OVERLAY THK. (to):	N/A	N/A
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	7-1/2"	21%	N/A	CIRC.	UPSTREAM	IHSI TREATED
1985	8"	18%	N/A	CIRC.	UPSTREAM	
1986	8"	18%	N/A	CIRC.	UPSTREAM	
1988	---------- NO REPORTABLE INDICATIONS ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 4.5"

AXIAL SHR.: 0.041"

WELD NO.: 02AS-89

WOR TYPE: 3

	UPSTREAM	DNSTREAM
CONFIGURATION:	VALVE	ELBOW
PIPE WALL THK. (tp):	N/A	1.363"
OVERLAY THK. (to):	N/A	0.488"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	1/2"	10%	N/A	AXIAL	ELBOW SIDE	"ENGINEERED" OVERLAY REPAIRED
	1"	9%	N/A	CIRC.	ELBOW SIDE	
	11"	23%	N/A	CIRC.	ELBOW SIDE	
	12"	13%	N/A	CIRC.	ELBOW SIDE	
1985	---------- NOT INSPECTED ----------					
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1988	---------- NO REPORTABLE INDICATIONS ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 7.3"

AXIAL SHR.: 0.081"

WELD NO.: 02AS-S12

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	1.387"	1.232"
OVERLAY THK. (to):	0.582"	0.557"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	3.2"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	8"	14%	N/A	CIRC.	PIPE SIDE	IHSI TREATED; FLAWED PIPE
	4"	11%	N/A	CIRC.	PIPE SIDE	EVALUATION PERFORMED
	1"	8%	N/A	CIRC.	ELBOW SIDE	
	2"	9%	N/A	CIRC.	ELBOW SIDE	
1985	8"	4%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
	6.5"	5%	N/A	CIRC.	PIPE SIDE	
	2.5"	15%	N/A	CIRC.	ELBOW SIDE	
1986	6"	4%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
	5"	13%	N/A	CIRC.	PIPE SIDE	
	2"	22%	N/A	CIRC.	ELBOW SIDE	
1988	8"	8%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
1990	---------- NO REPORTABLE INDICATIONS ----------					"STANDARD" OVERLAY REPAIRED
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28" WELD NO.: 02AS-F14

DIM. "D": 6.6" WOR TYPE: 1

AXIAL SHR.: 0.052"

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	1.235"	1.360"
OVERLAY THK. (to):	0.570"	0.570"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	2.8"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	43"	20%	N/A	CIRC.	PIPE SIDE	IHSI TREATED; FLAWED PIPE
	*	30%	N/A	SPOT	ELBOW SIDE	EVALUATION PERFORMED
1985	43" (intermit	13%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
1986	43" (intermit	14%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
1988	42.5" (intermit.)**	12%	N/A	CIRC.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
1990	---------- NO REPORTABLE INDICATIONS ----------					"STANDARD" OVERLAY REPAIRED
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

* THIS INDICATION HAS NO MEASURABLE LENGTH.
** 42-1/2" IS THE TOTAL EXTENT OF THE FLAWS WITH A COMBINED LENGTH OF 34-1/2".

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 8.0"

AXIAL SHR.: 0.065"

WELD NO.: 02BD-56

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	1.420"	1.349"
OVERLAY THK. (to):	0.530"	0.670"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	4.0"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	17"	39%	N/A	CIRC.	ELBOW SIDE	"ENGINEERED" OVERLAY REPAIRED
	1-1/4"	64%	N/A	AXIAL	ELBOW SIDE	
1985	---------- NOT INSPECTED ----------					
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1988	2.75"	N/A	0.58"	CIRC.	PIPE SIDE	
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 7.5"

AXIAL SHR.: 0.056"

WELD NO.: 02BD-F9

WOR TYPE: I

	UPSTREAM	DNSTREAM
CONFIGURATION:	VALVE	ELBOW
PIPE WALL THK. (tp):	1.455"	1.397"
OVERLAY THK. (to):	0.690"	0.560
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	4.7"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	---------- ROOT GEOMETRY ----------					IHSI TREATED
1985	---------- NOT INSPECTED ----------					
1986	4.5" total	15%	N/A	CIRC.	ELBOW SIDE	FLAWED PIPE EVALUATION PERFORMED
1988	3.0" w/ AXIAL COMPONENT	0.34"	N/A	CIRC.	ELBOW SIDE	FLAWED PIPE EVALUATION PERFORMED
	3.0"	0.35"	N/A	CIRC.	ELBOW SIDE	
	3.0"	0.35"	N/A	CIRC.	ELBOW SIDE	
1990	---------- NO REPORTABLE INDICATIONS ----------					"STANDARD" OVERLAY REPAIRED
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 9.0"

AXIAL SEN.: 0.044"

WELD NO.: 01BS-F1

WOR TYPE: 2

	UPSTREAM	DNSTREAM
CONFIGURATION:	SAFE END	ELBOW
PIPE WALL THK. (tp):	1.260"	1.393"
OVERLAY THK. (to):	0.57"	0.508"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	4.5"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	---------- NO REPORTABLE INDICATIONS ----------					IHSI TREATED
1985	---------- NO REPORTABLE INDICATIONS ----------					
1986	BEFORE OVERLAY REPAIR:					
	15"	73%	N/A	CIRC.	ELBOW SIDE	
	AFTER OVERLAY REPAIR:					"STANDARD" OVERLAY REPAIRED
	---------- NO REPORTABLE INDICATIONS ----------					
1988	---------- NO REPORTABLE INDICATIONS ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 8.3"

AXIAL SHR.: 0.067"

WELD NO.: 02BS-53

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	1.418"	1.232"
OVERLAY THK. (to):	0.492"	0.495"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	4.2"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	12"	40%	N/A	CIRC.	ELBOW SIDE	"ENGINEERED" OVERLAY REPAIRED
1985	---------- NOT INSPECTED ----------					
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1988	1.0"	N/A	0.48"	CIRC.	ELBOW SIDE	
	2.0"	N/A	0.44"	CIRC.	ELBOW SIDE	
1990	0.35"	N/A	0.51"	CIRC.	---	
	0.25"	N/A	0.60"	CIRC.	---	
1992	---------- NOT INSPECTED ----------					
1993	0.30"	N/A	0.52"	CIRC.	---	
	0.30"	N/A	0.58"	CIRC.	---	

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 7.3"

AXIAL SHR.: 0.091"

WELD NO.: 22BS-F7

WOR TYPE: 2

	UPSTREAM	DNSTREAM
CONFIGURATION:	VALVE	PIPE
PIPE WALL THK. (tp):	N/A	1.250"
OVERLAY THK. (to):	N/A	0.484"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	4.1"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	360 DEG.	16%	N/A	CIRC.	PIPE SIDE	"ENGINEERED" OVERLAY REPAIRED
1985	---------- NOT INSPECTED ----------					
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1988	---------- NO REPORTABLE INDICATIONS ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": 6.8"

AXIAL SHR.: 0.060"

WELD NO.: 02B6-S12

WOR TYPE: 1

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	1.417"	1.247"
OVERLAY THK. (to):	0.525"	0.557"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	4.1"	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	32"	16%	N/A	CIRC. ROOT GEOM.	PIPE SIDE	IHSI TREATED; FLAWED PIPE EVALUATION PERFORMED
1985	36"	21%	N/A	CIRC. ROOT GEOM.	PIPE SIDE	CALLED "ROOT GEOMETRY" ONLY
1986	36"	13%	N/A	CIRC. ROOT GEOM.	PIPE SIDE	CALLED "ROOT GEOMETRY" ONLY
1988	36"	13%	N/A	CIRC. ROOT GEOM.	PIPE SIDE	FLAWED PIPE EVALUATION PERFORMED
1990	---------- NO REPORTABLE INDICATIONS ----------					"STANDARD" OVERLAY REPAIRED
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 28"

DIM. "D": N/A

AXIAL SHR.: N/A

WELD NO.: 02BS-F14

WOR TYPE: N/A

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	ELBOW
PIPE WALL THK. (tp):	1.22"	1.34"
OVERLAY THK. (to):	N/A	N/A
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	5-1/4"	18%	N/A	CIRC.	PIPE SIDE	IHSI TREATED
1985	1" WITH I.D. ROOT GEOMETRY	16%	N/A	CIRC.	UPSTREAM	
1986	---------- I.D. ROOT GEOMETRY ----------					
1988	---------- I.D. ROOT GEOMETRY ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

PIPE SIZE: 20"

DIM. "D": 4.3"

AXIAL SHR.: 0.086"

WELD NO.: 105-F1

WOR TYPE: 2

	UPSTREAM	DNSTREAM
CONFIGURATION:	TEE	PIPE
PIPE WALL THK. (tp):	N/A	1.016"
OVERLAY THK. (to):	N/A	0.491"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	3.25"

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	6"	11%	N/A	CIRC.	PIPE SIDE	"ENGINEERED" OVERLAY REPAIRED
1985	---------- NOT INSPECTED ----------					
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1992	---------- NOT INSPECTED ----------					
1993	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.wk1/all)

WELD NO.: 10S-F5

WOR TYPE: 3

PIPE SIZE: 20"

DIM. "D": 3.8"

AXIAL SHR.: 0.069"

	UPSTREAM	DNSTREAM
CONFIGURATION:	VALVE	PIPE
PIPE WALL THK. (tp):	N/A	1.021"
OVERLAY THK. (to):	N/A	0.543"
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	3-1/2"	18%	N/A	CIRC.	PIPE SIDE	IHSI TREATED
	8"	12%	N/A	CIRC.	PIPE SIDE	
1985	9"	11%	N/A	CIRC.	PIPE SIDE	"ENGINEERED" OVERLAY REPAIRED
	10"	17%	N/A	CIRC.	PIPE SIDE	
	3"	13%	N/A	CIRC.	PIPE SIDE	
1986	---------- NO REPORTABLE INDICATIONS ----------					BUILT-UP TO "STANDARD" OVERLAY
1988	---------- NO REPORTABLE INDICATIONS ----------					
1990	---------- NO REPORTABLE INDICATIONS ----------					

(QC2FLAW.vk1/all)

PIPE SIZE: 6.625"

DIM. "D": N/A

AXIAL SHR.: N/A

WELD NO.: 12S-S24

WOR TYPE: N/A

	UPSTREAM	DNSTREAM
CONFIGURATION:	FLUED HEAD	PIPE
PIPE WALL THK. (tp):	0.432"	0.432"
OVERLAY THK. (to):	N/A	N/A
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1988	3.75"	0.22"	N/A	CIRC.	PIPE SIDE	"STANDARD" OVERLAY REPAIRED
	6.2"	0.21"	N/A	CIRC.	PIPE SIDE	
	---	100%	N/A	AXIAL	PIPE SIDE	
	---	0.10"	N/A	AXIAL	PIPE SIDE	
1990						REPLACED

(QC2FLAW.wk1/all)

PIPE SIZE: 6.625"

DIM. "D": N/A

AXIAL SHR.: N/A

WELD NO.: 12S-F26R

WOR TYPE: N/A

	UPSTREAM	DNSTREAM
CONFIGURATION:	PIPE	PIPE
PIPE WALL THK. (tp):	0.432"	0.432"
OVERLAY THK. (to):	N/A	N/A
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	N/A

OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1988	0.75"	0.10"	N/A	CIRC.	PIPE SIDE	"STANDARD" OVERLAY REPAIRED
1990						REPLACED

(QC2FLAW.wk1/all)

PIPE SIZE: 6.625"

DIM. "D": N/A

AXIAL SHR.: N/A

WELD NO.: 126-527*

WOR TYPE: N/A

* RENUMBERED 126-F2

	UPSTREAM	DNSTREAM
CONFIGURATION:	ELBOW	PIPE
PIPE WALL THK. (tp):	0.432"	0.432"
OVERLAY THK. (to):	N/A	N/A
LOW DELTA FERRITE FIRST LAYER THK.:	N/A	N/A
DIMENSION "A":	N/A	N/A

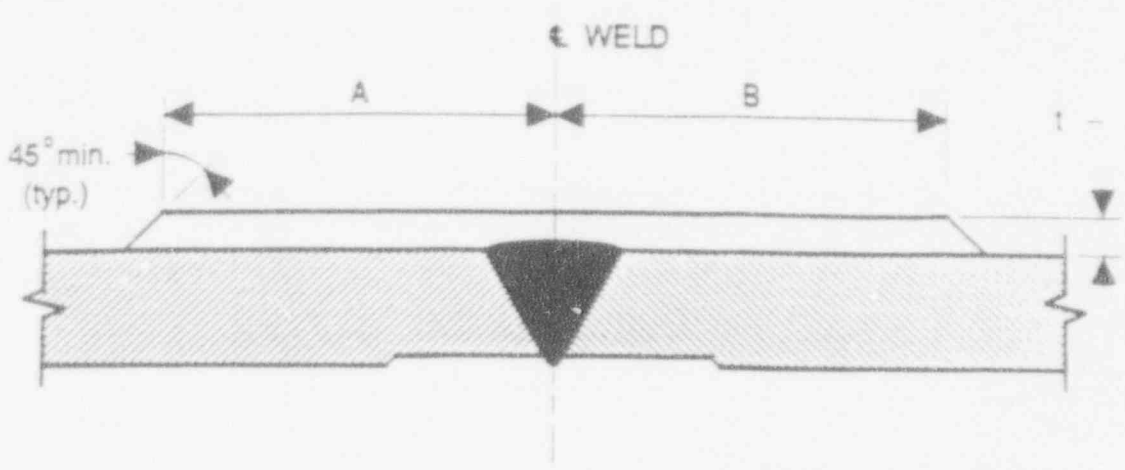
OUTAGE	LENGTH	DEPTH	REMAINING LIGAMENT	ORIENT.	LOCATION	COMMENT
1983	1-1/4"	20%	N/A	CIRC.	ELBOW SIDE	REPLACED

(QC2FLAW.wk1/all)

Appendix B

QUAD CITIES UNIT 2
WELD OVERLAY DESIGN DRAWINGS

Weld ID	Design Drawing No.	Rev. No.
02C-F7	Pacific Nuclear Dwg. No. XCE-42-254	0
02C-S3	NUTECH Dwg. No. CEC-73-125	0
02C-S4	SIA Dwg. No. CECo-09-013	0
02D-F6	NUTECH Dwg. No. CEC-47-206	0
02D-S3	SIA Dwg. No. CECo-09-001	0
02E-F6A	NUTECH Dwg. No. CEC-47-208	0
02E-S3	SIA Dwg. No. CECo-09-006	0
02F-F6	NUTECH Dwg. No. CEC-47-209	0
02F-S3	SIA Dwg. No. CECo-09-007	0
02G-S3	NUTECH Dwg. No. CEC-47-210	0
02G-S4	SIA Dwg. No. CECo-09-015	0
02H-S3	SIA Dwg. No. CECo-09-010	0
02H-S4	SIA Dwg. No. CECo-09-014	0
02J-F6	NUTECH Dwg. No. CEC-47-211	0
02J-S3	SIA Dwg. No. CECo-09-009	0
02J-S4	SIA Dwg. No. CECo-09-003	0
02K-F6	SIA Dwg. No. CECo-09-008	1
02K-S3	NUTECH Dwg. No. CEC-73-123	1
02K-S4	NUTECH Dwg. No. CEC-73-124	1
02L-S3	SIA Dwg. No. CECo-09-002	1
02L-S4	SIA Dwg. No. CECo-09-004	0
02M-F7	NUTECH Dwg. No. CEC-47-212	0
02M-S3	NUTECH Dwg. No. CEC-47-213	0
02M-S4	SIA Dwg. No. CECo-09-005	0
02B-S9	NUTECH Dwg. No. CEC-47-218	1
02AD-F12	NUTECH Dwg. No. XCE-42-200	0
02AD-S6	NUTECH Dwg. No. XCE-42-202	0
02AS-F14	NUTECH Dwg. No. XCE-42-203	1
02AS-S12	NUTECH Dwg. No. XCE-42-204	0
02AS-S4	NUTECH Dwg. No. CEC-47-221	0
02AS-S9	NUTECH Dwg. No. CEC-47-223	0
02BD-F8	NUTECH Dwg. No. XCE-42-201	0
02BD-S6	NUTECH Dwg. No. CEC-47-224	0
02BS-F2	NUTECH Dwg. No. CEC-73-126	0
02BS-F7	NUTECH Dwg. No. CEC-47-226	1
02BS-S12	NUTECH Dwg. No. XCE-42-205	1
02BS-S3	NUTECH Dwg. No. CEC-47-228	0
10S-F1	NUTECH Dwg. No. CEC-47-215	0
10S-F5	NUTECH Dwg. No. CEC-47-216	1



U.S. PATENT NO. 4,624,402

WELD OVERLAY REPAIR DESIGN

NOTES:

(1) THIS REPAIR SHALL COMPLY WITH THE TECHNICAL REQUIREMENTS CONTAINED IN DOCUMENT NO. COE-107-500, REVISION 0.

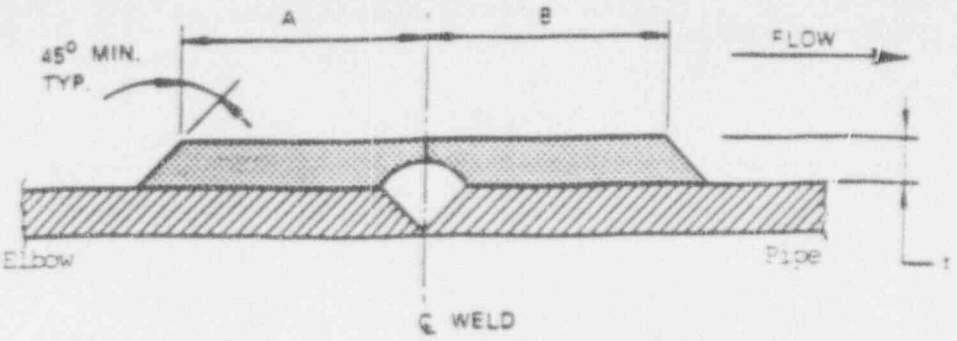
(2) EXTEND OVERLAY AS FAR AS PRACTICAL TOWARD SWEEPOLET. HOWEVER "A" DIMENSION NEED NOT EXCEED 2.0".

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02C-	5" LONG x 18-20% DEPTH CIRC. WITH 0.3" LONG x 68-72% DEPTH AXIAL	0.26"	(2)	2.25"	NUREG-0313, REV. 2 "STANDARD" WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	4/2/93	4/2/93	4/2/93	4/2/93	4/2/93	ISSUED FOR CONSTRUCTION

JOB NO.:	PLANT/UNIT:			REV
COE-279	QUAD CITIES UNIT 2	PACIFIC NUCLEAR Engineering Services Group	SHT 1 OF 1	0
FILE NO.: XCE042.0254	SKETCH NO.: XCE-42-254			

(P PWOR DWG)

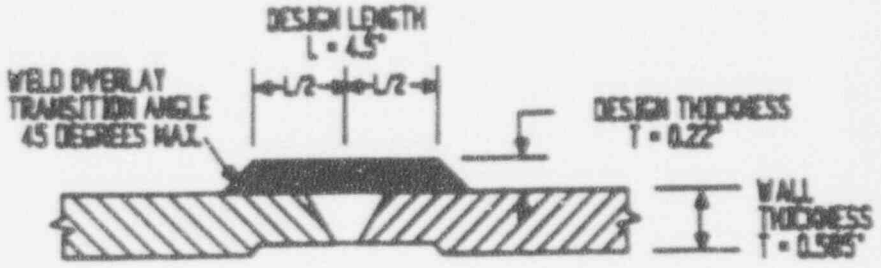


WELD OVERLAY
REPAIR DETAILS

Patent applied for

	WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
			t	A	B	
	CEC-S3	100% x 360°	0.28"	2.00"	2.00"	Full Structural WOR
0	CWJ 11/25/86	WGC 11/25/86	WGC 11/25/86	CWJ 11/25/86	CWJ 11/25/86	Initial Issue
REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION

JOB NO: CEC-73	PLANT: Quad Cities 2	nytech	SHT. 1 OF 1
FILE NO: CEC073.0125	DWG. NO: CEC-73-125		REV. 0



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02C-54

MODIFICATION AND/OR WORK REQUEST

N/A	Q 66715

ID PROGRAM

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-88-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

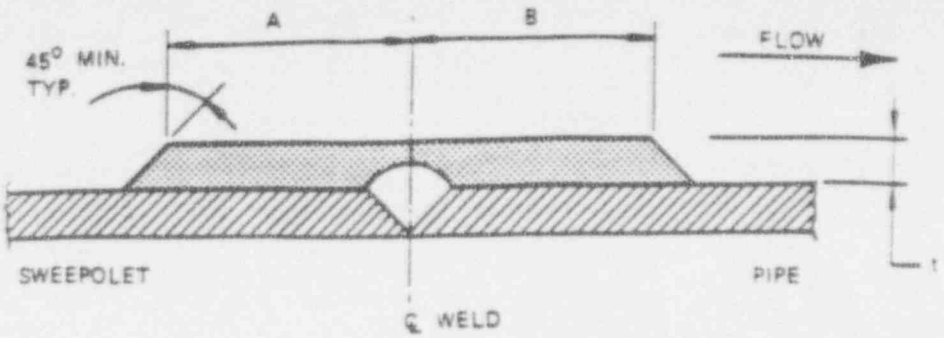
DRAWING NUMBER: CECO-88-013 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-008

PREPARED BY/DATE [signature] 5/12/88

REVIEWED BY/DATE [signature] 5/12/88

ISSUED BY/DATE J.F. Copeland 5/12/88

[redacted]



WELD OVERLAY REPAIR DETAILS

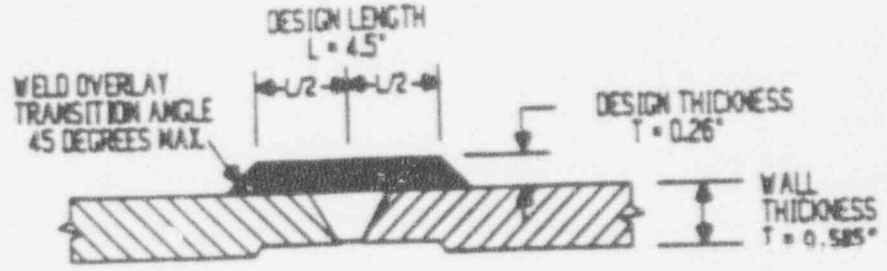
Patent applied for

(1) EXTEND OVERLAY AS FAR AS PRACTICAL TOWARD SWEEPOLET. HOWEVER "A" DIMENSION NEED NOT EXCEED 2.0"

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02D-F8	100% x 360°	0.25"	(1)	2.0"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	JAEK/6-30-86	CTS/6-30-86	CHF 6/30/86	CHF 6/30/86	CHF 6/30/86	

NO: CEC-47	PLANT: QUAD CITIES UNIT 2	nytech	SHT 1 OF 1	REV 0
FILE NO: CEC047.0206	DWG. NO: CEC-47-206			



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 020-S3

[redacted]

n/a

[redacted]

IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-88-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

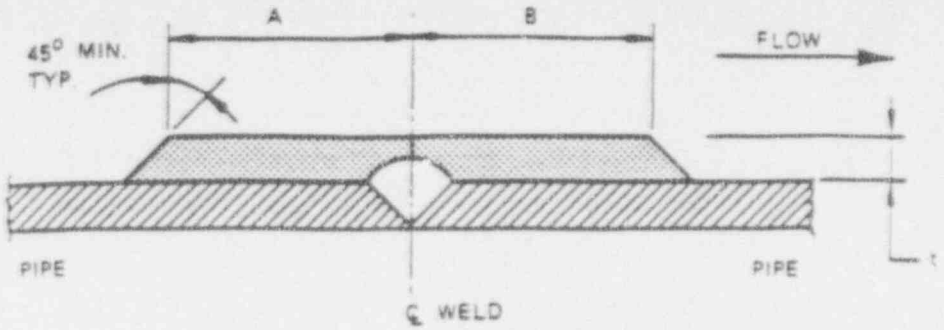
DRAWING NUMBER: CECO-09-001 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-090

PREPARED BY/DATE [redacted] April 28, 1989

REVIEWED BY/DATE J.F. Copeland 4/28/89

ISSUED BY/DATE J.F. Copeland 4/28/89

[redacted]



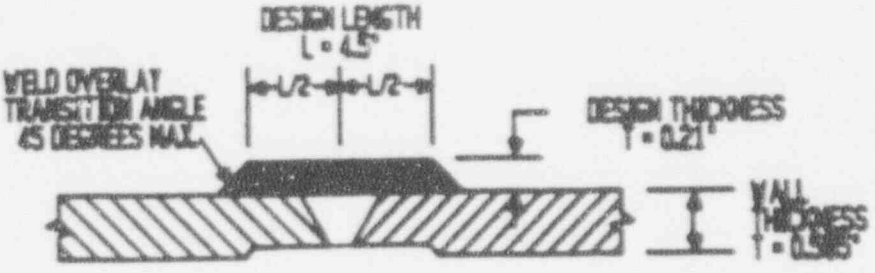
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02E-F6A	100% x 360°	0.25"	2.0"	2.0"	FULL STRUCTURAL WOR DESIGN
0	[illegible] 6-30-86	CTS 6-30-86	6/30/86	6/30/86	6/30/86	

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION

B NO:	PLANT:			REV
CEC-47	QUAD CITIES UNIT 2	nytech	SHT. 1	0
FILE NO: CEC047.0208	DWG. NO: CEC-47-208		OF 1	



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02E-S3

MODIFICATION AND/OR WORK REQUEST

N/A	Q6652%

IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION 515-00-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

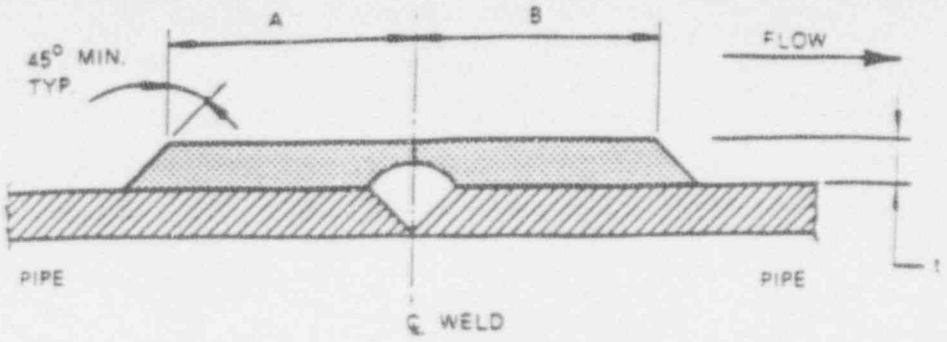
DRAWING NUMBER: CEDO-00-006 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CEDO-000

PREPARED BY/DATE [signature] 6/6/88

REVIEWED BY/DATE [signature] 5/4/88

ISSUED BY/DATE J. F. [signature] 5/4/88

[redacted]



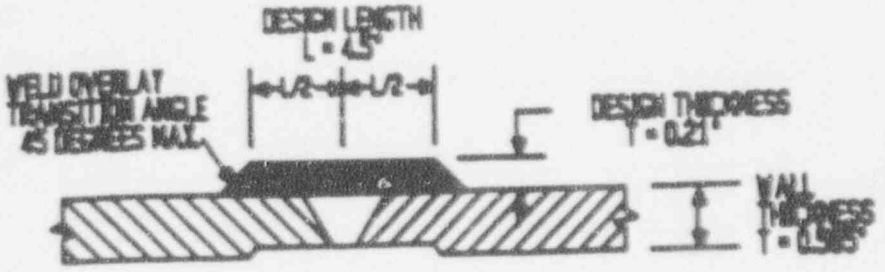
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02F-F8	100% x 360°	0.25"	2.0"	2.0"	FULL STRUCTURAL WOR DESIGN
0	[illegible] 6-30-86	CTS 6-30-86	6/30/86	6/30/86	6/30/86	

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION

J NO:	PLANT:		SHT 1	REV
CEC-47	QUAD CITIES UNIT 2	nytech	OF 1	0
FILE NO: CEC047.0209	DWG. NO: CEC-47-209			



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02B-53

MODIFICATION AND/OR WORK REQUEST

N/A | Q.66545

IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-00-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

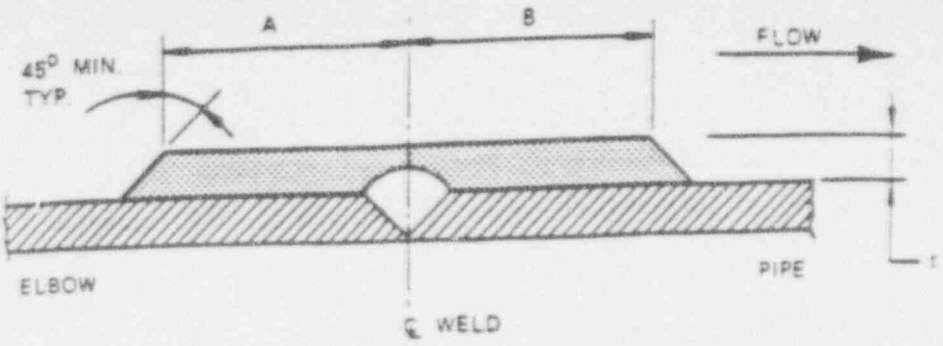
DRAWING NUMBER: CECO-00-0017 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-000

PREPARED BY/DATE: [signature] 5/6/94

REVIEWED BY/DATE: [signature] 5/6/94

ISSUED BY/DATE: J.F. Copeland 5/6/94

[redacted] Associates, Inc.



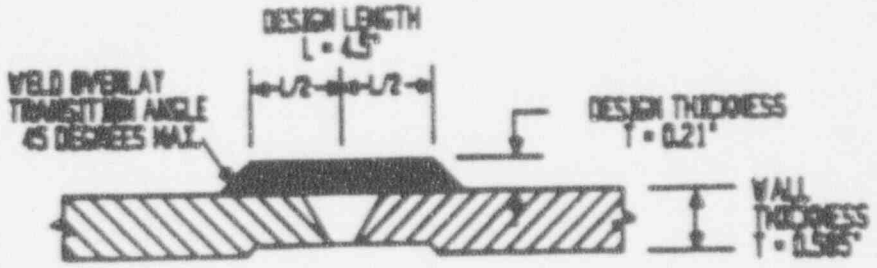
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02[illegible]53	100% x 360°	0.25"	2.0"	2.0"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	[illegible] 6-30-86	CJS 6-30-86	CHF 6/30/86	CHF 6/30/86	CHF 6/30/86	

B NO: CEC-47	PLANT: QUAD CITIES UNIT 2	nytech	SHT. 1	REV 0
FILE NO: CECD47.0210	DWG. NO: CEC-47-210		OF 1	



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02B-54

MODIFICATION AND/OR WORK REQUEST

N/A | Q46544

(IF APPLICABLE)

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION 525-00-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

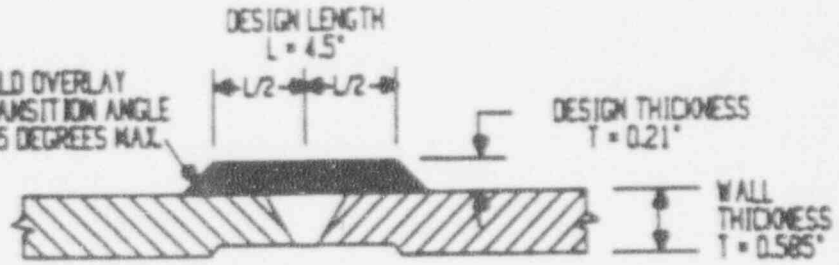
DRAWING NUMBER: CECO-00-015 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-000

PREPARED BY/DATE [signature] 5/12/00

REVIEWED BY/DATE [signature] 5/12/00

ISSUED BY/DATE T.E. Copeland 5/12/00

[redacted]



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02H-53

[redacted] WORK REQUEST

N/A	Q66601

IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-88-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

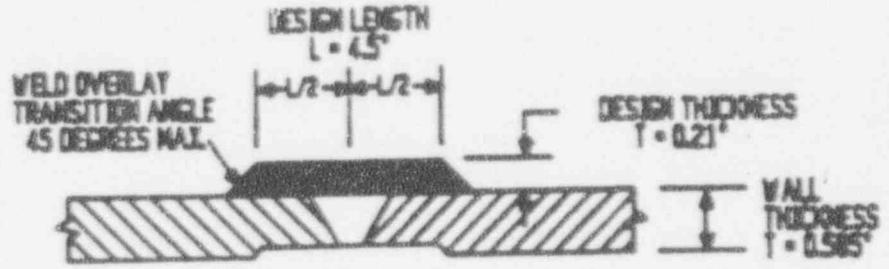
DRAWING NUMBER: CECO-09-010 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-090

PREPARED BY/DATE [redacted] 5/6/88

REVIEWED BY/DATE [redacted]

ISSUED BY/DATE [redacted]

[redacted] Inc



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02H-54

MODIFICATION AND/OR WORK REQUEST
N/A	QQ4714

IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-88-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

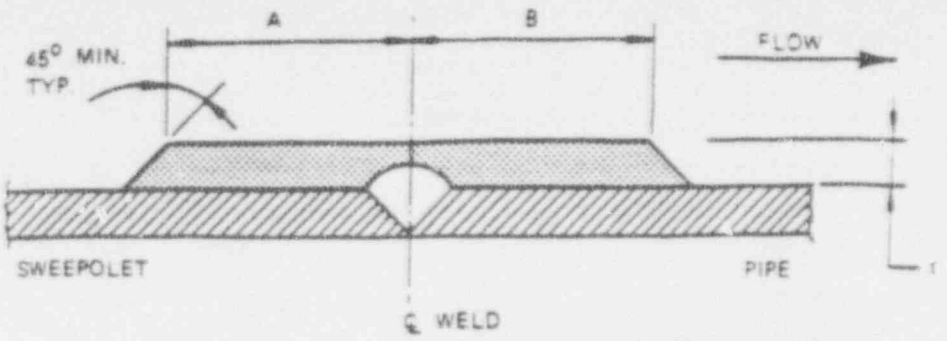
DRAWING NUMBER: CECO-88-014 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-088

PREPARED BY/DATE [redacted] 5/12/88

REVIEWED BY/DATE [redacted] 5/12/88

ISSUED BY/DATE J. F. Copeland 5/12/88

[redacted] Inc.



WELD OVERLAY REPAIR DETAILS

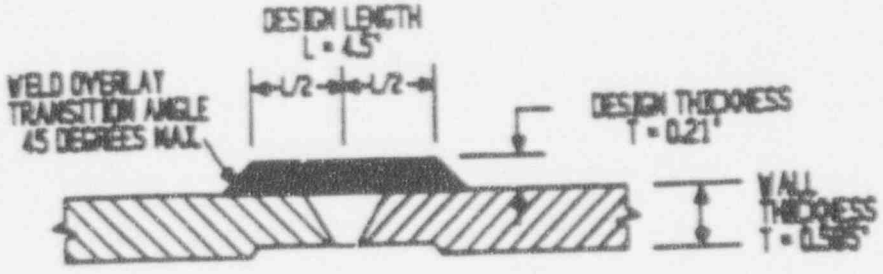
Patent applied for

(1) EXTEND OVERLAY AS FAR AS PRACTICAL TOWARD SWEEPOLET. HOWEVER "A" DIMENSION NEED NOT EXCEED 2.0"

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02J-F6	100% x 380°	0.25"	(1)	2.0"	FULL STRUCTURAL WOR DESIGN
0	6-30-86	6-30-86	6/30/86	6/30/86	6/30/86	

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION

NO: CEC-47	PLANT: QUAD CITIES UNIT 2	nytech	SHT. 1 OF 1	REV 0
FILE NO: CEC047.0211	DWG. NO: CEC-47-211			



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02J-S3

MODIFICATION AND/OR WORK REQUEST

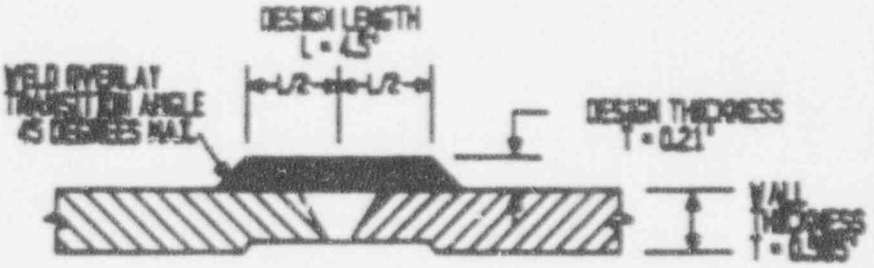
N/A	246602

IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-00-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

DRAWING NUMBER: CECO-00-0000 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-0000

PREPARED BY/DATE N Z Ln 5/4/88
REVIEWED BY/DATE [signature] 5/4/88
ISSUED BY/DATE J F. Egelhoff 5/4/88



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02-54

MODIFICATION [illegible]

[illegible] | Q66359

IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-00-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

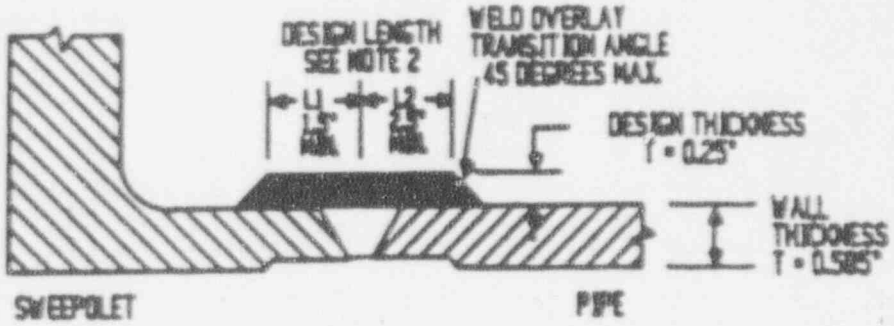
DRAWING NUMBER: CECO-00-003 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-000

PREPARED BY/DATE [signature] 6/9/00

REVIEWED BY/DATE [signature] 6/9/00

ISSUED BY/DATE [signature]

[redacted]



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02K-FB

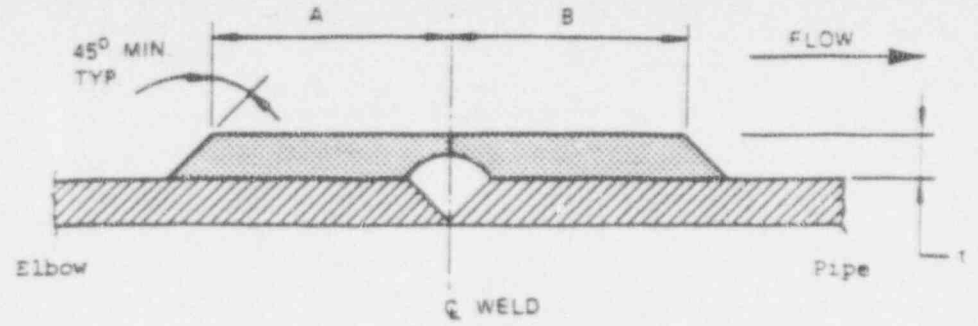
MODIFICATION AND/OR WORK REQUEST
N/A | Q66717
IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-88-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH. LENGTH ON THE SWEEPOLET SIDE IS RESTRICTED BY THE SWEEPOLET GEOMETRY. THE FULL THICKNESS LENGTH OF THE REPAIR IS TO BE AT LEAST 1.5" ON THE SWEEPOLET SIDE, UNLESS THE REPAIR CAN BE BLENDED INTO THE SWEEPOLET TRANSITION PRIOR TO ACHIEVING THAT LENGTH. LENGTH ON THE PIPE SIDE SHALL BE AT LEAST 2.5".

DRAWING NUMBER: CECO-88-003 REVISION: 1 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-088

PREPARED BY/DATE N Z Dunton 5/12/88
REVIEWED BY/DATE [illegible] 5/12/88
ISSUED BY/DATE J.E. Copeland 5/12/88

[redacted] INC.



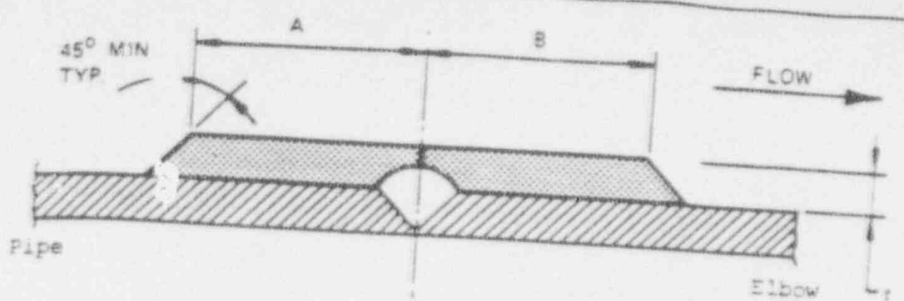
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02K-S3	100% x 360°	0.26"	2.0"	2.0"	Full-structural weld overlay repair design

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
1	CWT 12/6/86	NGC 12/6/86	NGC 12/6/86	CWT 12/6/86	CWT 12/6/86	Revised assumed flaw size
0	CWT 11/10/86	NGC 11/10/86	NGC 11/10/86	CWT 11/10/86	CWT 11/10/86	Initial Issue

JOB NO:	PLANT:		SHT. 1 OF 1	REV
CEC-73	Quad Cities Unit 2	nytech		1
FILE NO: CEC073.0123	DWG. NO: CEC-73-123			



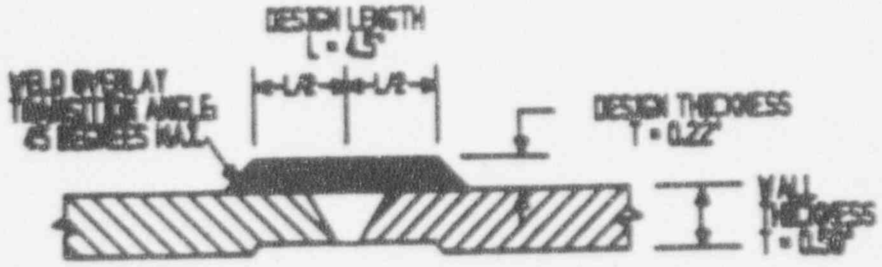
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02K-54	100% x 360°	0.25"	2.0"	2.0"	Full-structural weld overlay repair design

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
1	CMJ 12/6/86	NGC 12/6/86	NGC 12/6/86	CMJ 12/6/86	CMJ 12/6/86	Revised assumed flaw size
0	CMJ 11/10/86	NGC 11/10/86	NGC 11/10/86	CMJ 11/10/86	CMJ 11/10/86	Initial Issue

JOB NO:	PLANT:			
CEC-73	Quad Cities Unit 2	nutech	SHT. 1 OF 1	REV 1
FILE NO: CEC073.0124	DWG. NO: CEC-73-124			



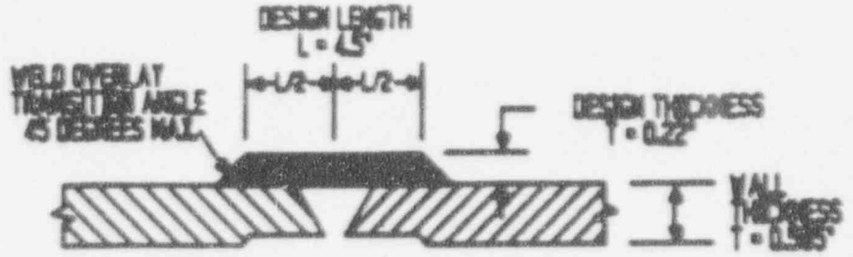
WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02L-S3

MODIFICATION	AHD OR WORK REQUEST
N/A	Q66338

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-88-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

DRAWING NUMBER: CECO-08-002 REVISION: 1 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-08Q

PREPARED BY/DATE ________
REVIEWED BY/DATE ________
ISSUED BY/DATE J. F. ________



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER 02L-54

MODIFICATION AUTHORIZATION OR WORK REQUEST
N/A
QUAD 2

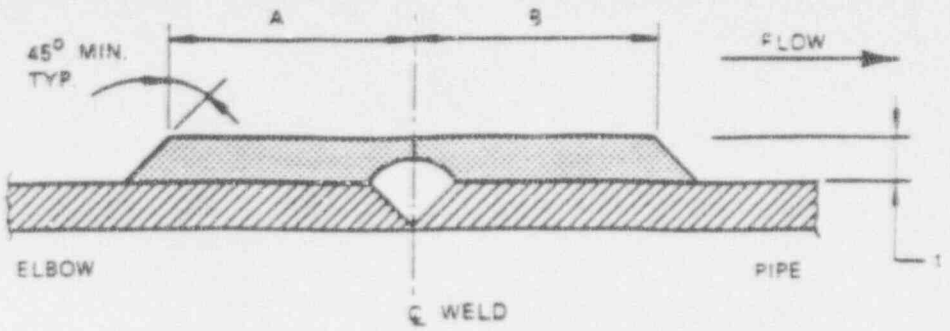
IN PROCESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-00-001, LATEST REVISION.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

DRAWING NUMBER: CEDO-00-0004 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CEDO-0000

PREPARED BY/DATE: [illegible] 6/6/00
REVIEWED BY/DATE: [illegible] 6/6/00
ISSUED BY/DATE: J. F. [illegible] 6/6/00

[illegible]



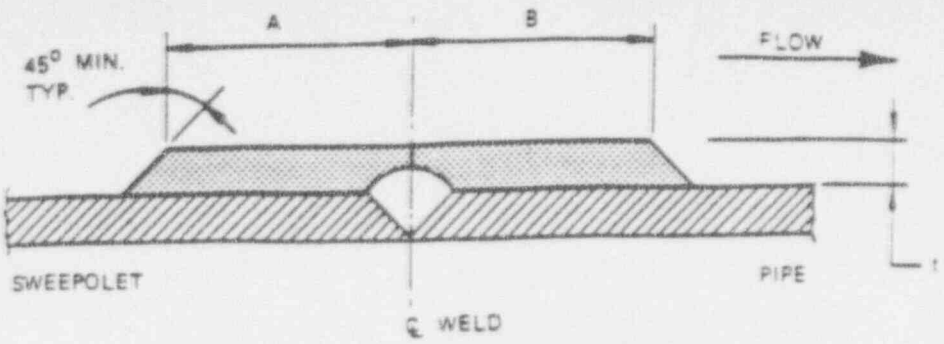
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02M-S3	100% x 360°	0.25"	2.0"	2.0"	FULL STRUCTURAL WOR DESIGN
0	[illegible] 6-30-86	CTS 6-30-86	CHT 6/30/86	CHT 6/30/86	CHT 6/30/86	

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION

JOB NO:	PLANT:			REV.
CEC-47	QUAD CITIES UNIT 2	nytech	SHT. 1	0
FILE NO: CEC047.0213	DWG. NO: CEC-47-213		OF 1	



WELD OVERLAY REPAIR DETAILS

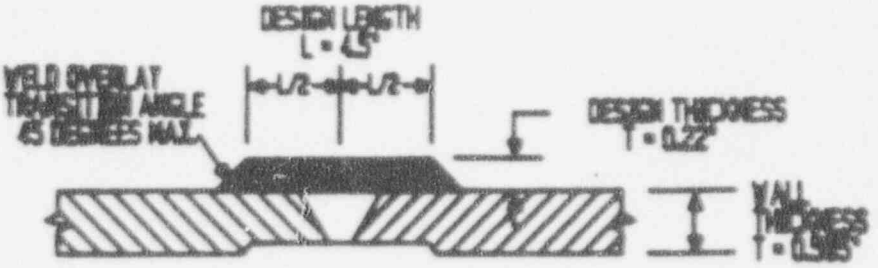
Patent applied for

(1) EXTEND OVERLAY AS FAR AS PRACTICAL TOWARD SWEEPOLET, HOWEVER "A" DIMENSION NEED NOT EXCEED 2.0"

	ELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
			t	A	B	
02[illegible]	7	100% x 360°	0.25"	(1)	2.0"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	[illegible] 6-30-86	CTS 6-30-86	6/30/86	6/30/86	6/30/86	

Y NO: CEC-47	PLANT: QUAD CITIES UNIT 2	nytech	SHT. 1 OF 1
FILE NO: CEC047.0212	DWG. NO: CEC-47-212		REV. 0



WELD OVERLAY DESIGN SKETCH
COMMONWEALTH EDISON COMPANY
QUAD CITIES UNIT 2
WELD NUMBER D2H-54

MODIFICATION AND/OR WORK REQUEST

N/A	Q66600

IN PROGRESS

NOTES:
1. THIS SKETCH TO BE WORKED WITH SPECIFICATION SIS-00-001, LATEST REV. DATED.
2. DESIGN LENGTH SHOWN IS FULL THICKNESS LENGTH.

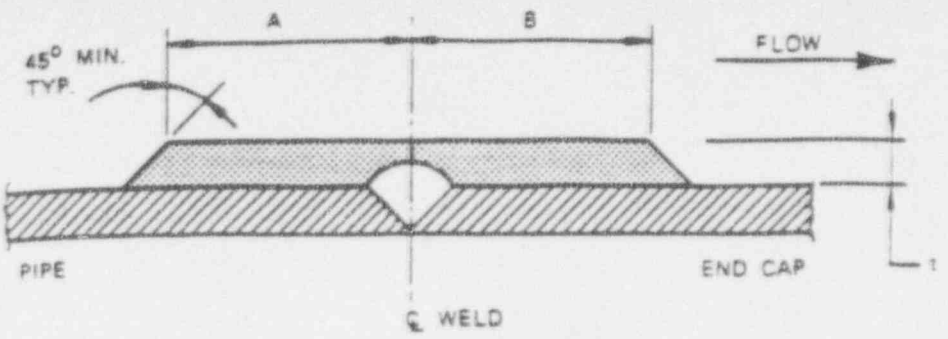
DRAWING NUMBER: CECO-00-005 REVISION: 0 PAGE: 1 OF 1
SI PROJECT NUMBER: CECO-000

PREPARED BY/DATE: [illegible] 5/6/91

REVIEWED BY/DATE: [illegible]

ISSUED BY/DATE: T.E. Copeland 5/6/91

[redacted]



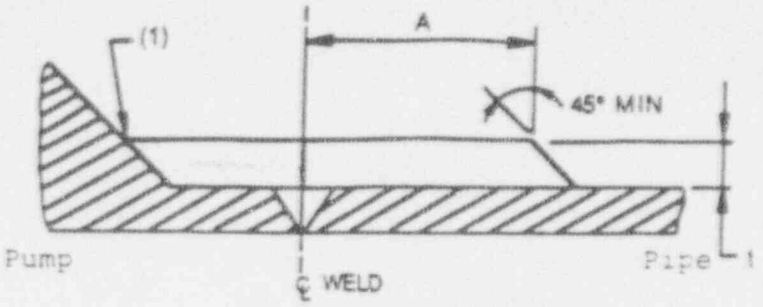
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02B-S9	100% x 360°	0.38"	3.0"	2.0"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
1	CMF 11/24/86	MGC 11/24/86	MGC 11/24/86	CMF 11/24/86	CMF 11/24/86	Revised WOR Length
0	[illegible] 6-30-PL	CTS 6-30-86	CMF 6/30/86	CMF 6/30/86	CMF 6/30/86	

B NO:	PLANT:		SHT. 1	REV
CEC47	QUAD CITIES UNIT 2	nytech	OF 1	1
FILE NO: CEC047.0218	DWG. NO: CEC-47-218			



WELD OVERLAY REPAIR DETAILS

Patent No. 4,624,402

Note:

(1) Toe of overlay to blend smoothly into pump transition

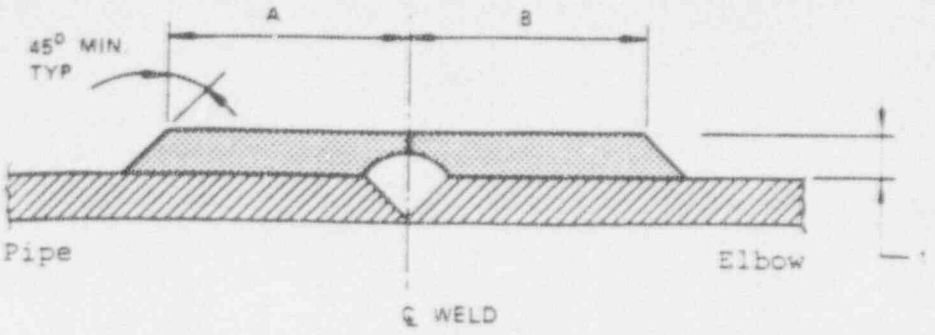
REF: CECo ECN No. 04-00024M
& NMOD/EWR-Q80667 CHG 1 2/24/89

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS		COMMENTS
		A	t	
02AD-F12	100% x 360°	4.25"	0.46"	Standard Weld Overlay Repair

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	PAC 3/3-6-89	MAC 3/6/89	MAC 3/6/89	MAC for CHG 2/6/89	CHG for CHG 3/6/89	Issued for Construction
A	PAC 2-17-89	MAC 2/17/89	MAC 2/17/89	CHG 2/24/89	CHG 2/24/89	Issued for Bids

JOB NO:	PLANT:		SHT. 1	REV.
XCE-42	Quad Cities Unit 2	nytech	OF 1	0
FILE NO: XCE042.0200	DWG. NO: XCE-42-200			

FMKTB6 01 01



WELD OVERLAY REPAIR DETAILS

U.S. PATENT No. 4,624,402

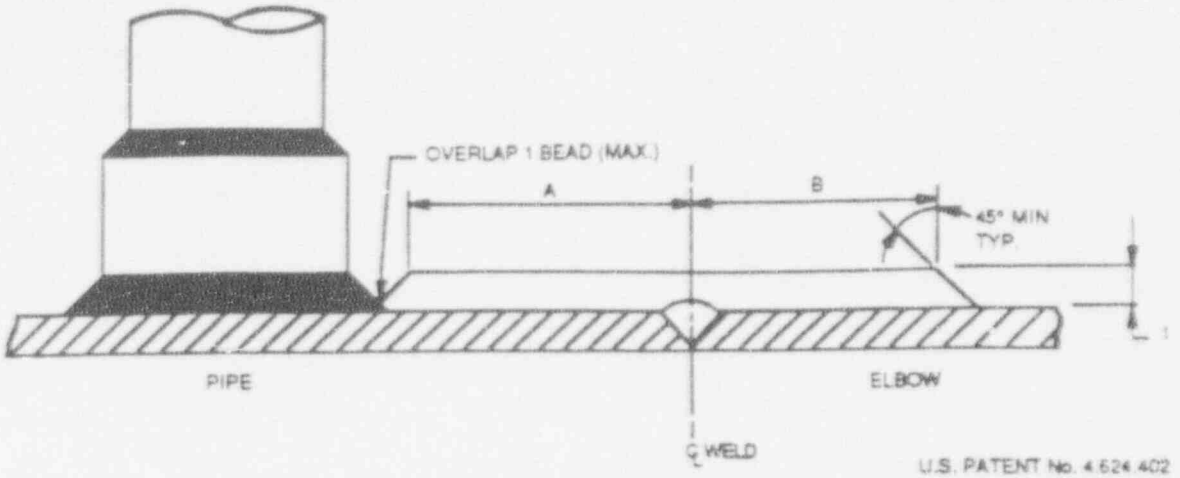
REF: CECo ECN No. 04-00021M
& NMOD/EWR-Q80663 CWJ 1/30/90

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02AD-S6	100% x 360°	0.46"	4.25"	4.25"	Standard Weld Overlay Repair

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	SMEW/ 2-17-89	NRC 2/17/89	NRC 2/17/89	CWJ 2/24/89	CWJ 2/24/89	Issued for Construction

JOB NO:	PLANT:		SHT 1	REV
XCE-42	Quad Cities Unit 2	nytech	OF 1	0
FILE NO: XCE042.0202	DWG. NO: XCE-42-202			

FMKTB6 01 22



U.S. PATENT No. 4,624,402

WELD OVERLAY REPAIR DETAILS

NOTES:

1. Overlay to extend toward branch line as far as possible. "A" dim. need not exceed 4.0" but shall not be less than 2.5".
2. Overlay to extend toward elbow until it can be blended smoothly into transition. "B" dim. need not exceed 4.0".

INCREASED TO 0.46" PER FCR NO. 4-90-121 CWJ 2/8/90

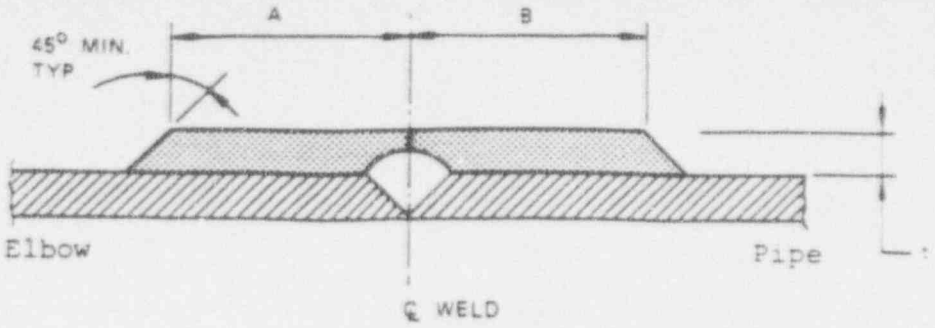
REF: CECo ECN No. 04-00023M & NMOD/EWR-Q80666 CWJ 1/30/90

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02AS-F14	100% x 360°	0.41"	(1)	(2)	Standard Weld Overlay Repair

REV	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
1	CWJ 4/11/90	1/17/90	CWJ 1/17/90	CWJ 1/17/90	DKG for JRS 1/17/90	Revised to include Interference
0	2-17-89	MSC 2/17/89	MSC 2/17/89	CWJ 2/20/89	CWJ 2/20/89	Issued for Construction

JOB NO:	PLANT:		SHT 1 OF 1	REV
XCE-42	Quad Cities Unit 2	nytech		1
FILE NO: XCE042.0203	DWG. NO: XCE-42-203			

FMKT86 01 02



WELD OVERLAY REPAIR DETAILS

U.S. PATENT No. 4 824 402

INCREASED TO 0.46" PER FCR NO. 4-90-122 CWJ 3/8/90

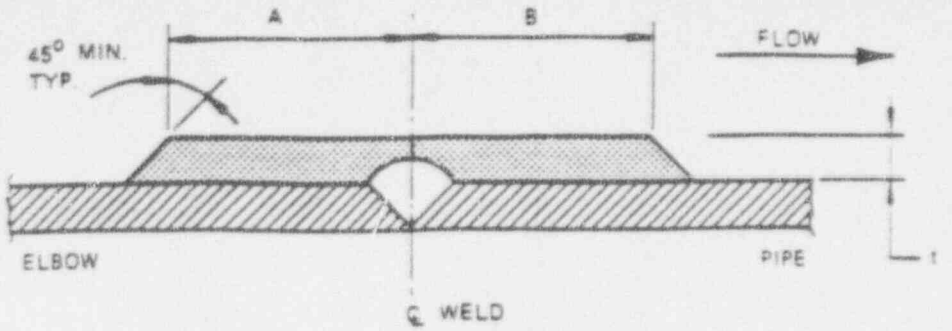
REDUCED TO 3.0" PER FCR NO. 4-90-114 CWJ 3/5/90

REF: CECo ECN No. 04-00022M & NMOD/EWR-Q80665 CWJ 1/30/90

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02AS-S12	100% x 360°	0.41"	4.0"	4.0"	Standard Weld Overlay Repair
0	SMG 2-17-89	MJC 2/17/89	NSC 2/17/89	CWJ 2/19/89	CWJ 2/19/89	Issued for Construction
REV	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION

JOB NO:	PLANT:		SHT 1	REV
XCE-42	Quad Cities Unit 2	nytech	OF 1	0
FILE NO: XCE042.0204	DWG. NO: XCE-42-204			

FMKT86 01 02

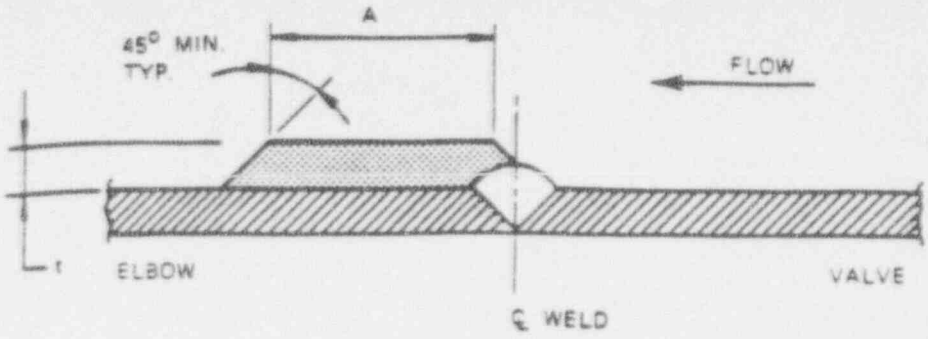


WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02AS-S4	100% x 360°	0.42"	4.0"	4.0"	FULL STRUCTURAL WOR DESIGN
0	6-30-86	CTS 6-30-86	6/30/86	6/30/86	6/30/86	
REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION

JOB NO: CEC47	PLANT: QUAD CITIES UNIT 2	nytech	SHT. 1 OF 1
FILE NO: CEC047.0221	DWG. NO: CEC-47-221		REV 0



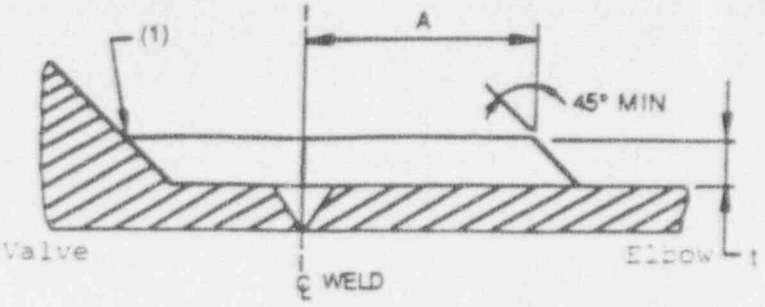
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS		COMMENTS
		A	t	
02AS-SB	100% x 360°	4.0"	0.42"	FULL STRUCTURAL WOR DESIGN
0	6-30-86	6-30-86	6/30/86	6/30/86	6/30/86	

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION

B NO:	PLANT:		SHT. 1	REV.
CEC-47	QUAD CITIES UNIT 2	nutech	OF 1	0
FILE NO: CEC047.0223	DWG. NO: CEC-47-223			



WELD OVERLAY REPAIR DETAILS

Patent No. 4,624,402

Note:

(1) Toe of overlay to blend smoothly into valve transition

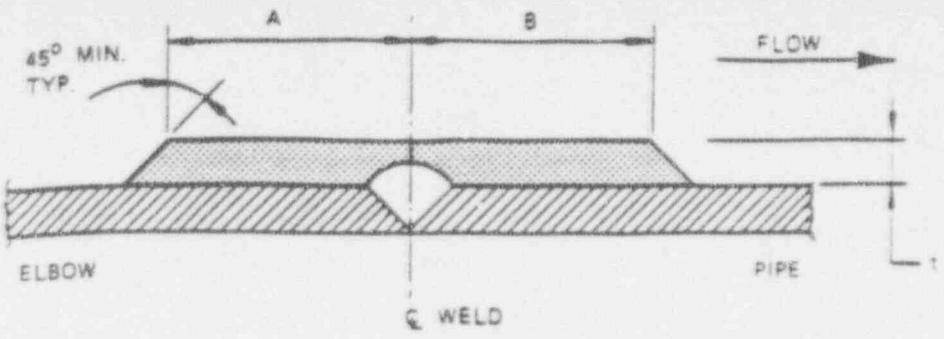
REF: CECo ECN No. 04-00026M
& NMOD/EWR-Q80669 CHF 1/30/90

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS		COMMENTS
		A	t	
02BD-F8	100% x 360°	4.25"	0.46"	Standard Weld Overlay Repair

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	[illegible] 3-6-89	NRC 3/6/89	NRC 3/6/89	NRC for CHF 3/6/89	CHF for CHF 3/6/89	Issued for Construction
A	[illegible] 2-17-89	NRC 2/17/89	NRC 2/17/89	CHF 2/24/89	CHF 2/24/89	Issued for Bids

JOB NO:	PLANT:		SHT. 1	REV.
XCE-42	Quad Cities Unit 2	nutech	OF 1	0
FILE NO: XCE042.0201	DWG. NO: XCE-42-201			

FMKT86 01-01



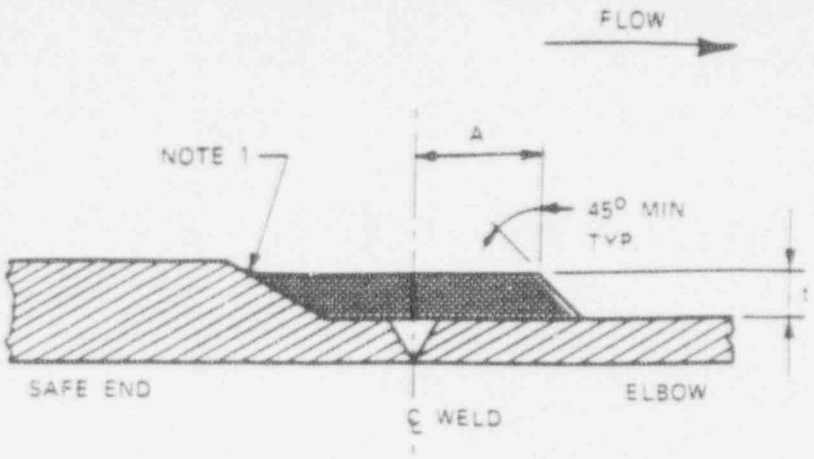
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
02BD-S6	100% x 360°	0.47"	4.0"	4.0"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	[illegible] 6-30-86	CTS 6-30-86	[illegible] 6/30/86	[illegible] 6/30/86	[illegible] 6/30/86	

I NO: CEC-47	PLANT: QUAD CITIES UNIT 2	nytech	SHT. 1 OF 1
FILE NO: CEC047.0224	DWG. NO: CEC-47-224		REV. 0



WELD OVERLAY REPAIR DETAILS

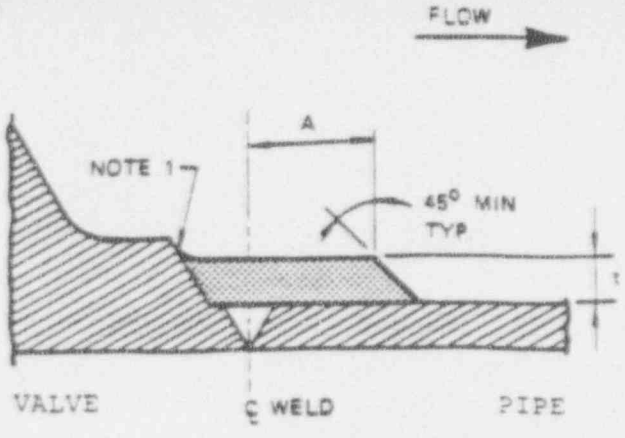
Patent applied for

NOTES:
1. Overlay to be blended smoothly into contour of Safe End.

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS		COMMENTS
		A	t	
02BS-F2	100% x 360°	4.0"	0.44"	Full-Structural WOR Design

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	12/9/86	12-9-86	12/9/86	12/9/86	12/9/86	Initial Issue

JOB NO:	PLANT:			REV.
CEC-73	QUAD CITIES UNIT 2	nytech	SHT. 1 OF 1	0
FILE NO: CEC073.0126	DWG. NO: CEC-73-126			



Patent applied for

WELD OVERLAY REPAIR DETAILS

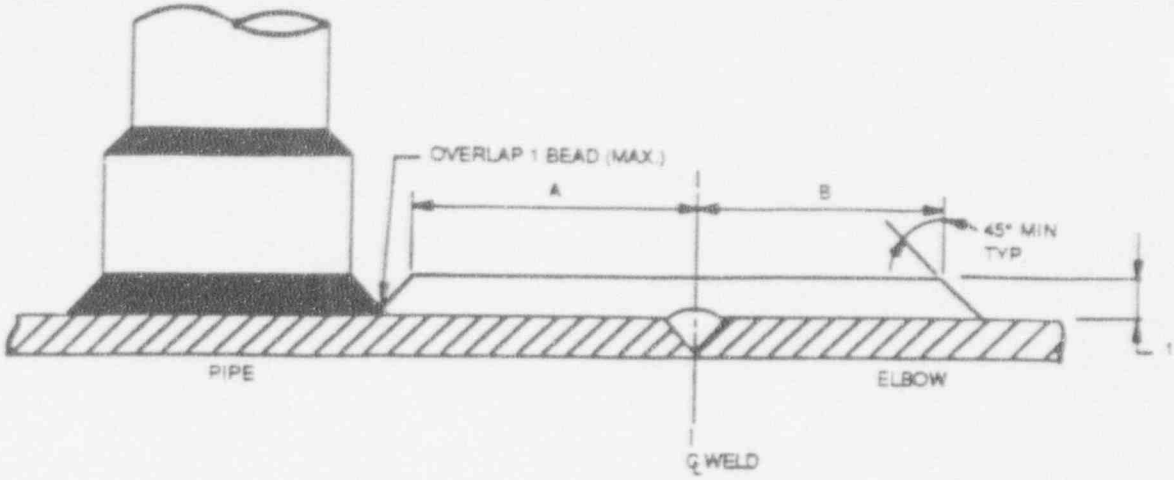
NOTE:

1. Overlay shall extend to valve with final surface of overlay blending smoothly into contour of valve.

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS		COMMENTS
		A	t	
028S-F7	100% x 360°	4.0"	0.42"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
1	[illegible] 10-24-86	WGC 10/24/86	WGC 10/24/86	[illegible] 10/24/86	[illegible] 10/24/86	Corrected sketch: added NOTE.
0	[illegible] 6-30-86	CJS 6-30-86	[illegible] 6/30/86	[illegible] 6/30/86	[illegible] 6/30/86	———

NO: CEC-47	PLANT: QUAD CITIES UNIT 2	nutech	SHT. 1 OF 1	REV. 1
FILE NO: CEC047.0226	DWG. NO: CEC-47-226			



U.S. PATENT No. 4,624,402

WELD OVERLAY REPAIR DETAILS

NOTES:

1. Overlay to extend toward branch line as far as possible. "A" dim. need not exceed 4.0" or shall not be less than 2.5".

INCREASED TO 0.43" PER FCR NO. 4-90-123 CMT 3/8/90

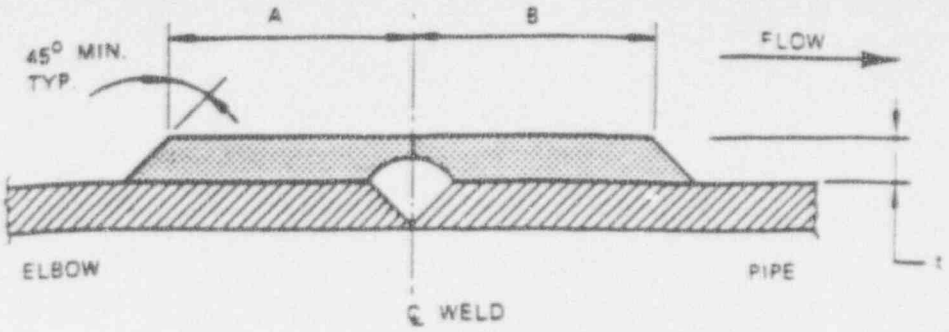
REF: CECo ECN No. 04-00025M & NMOD/EWR-Q80668 CMT 1/30/90

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS t	A	B	COMMENTS
02BS-S12	100% x 360°	0.41"	(1)	4.0"	Standard Weld Overlay Repair

REV	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
1	CMT 1/17/90	1/17/90	CMT 1/17/90	CMT 1/17/90	okay for JCS 1/17/90	Revised to include interference
0	2-17-89	mac 2/17/89	mac 2/17/89	CMT 2/24/89	CMT 2/24/89	Issued for Construction

JOB NO:	PLANT:		SHT 1 OF 1	REV
XCE-42	Quad Cities Unit 2	nytech		1
FILE NO: XCE042.0205	DWG. NO: XCE-42-205			

FMKT86 01.02



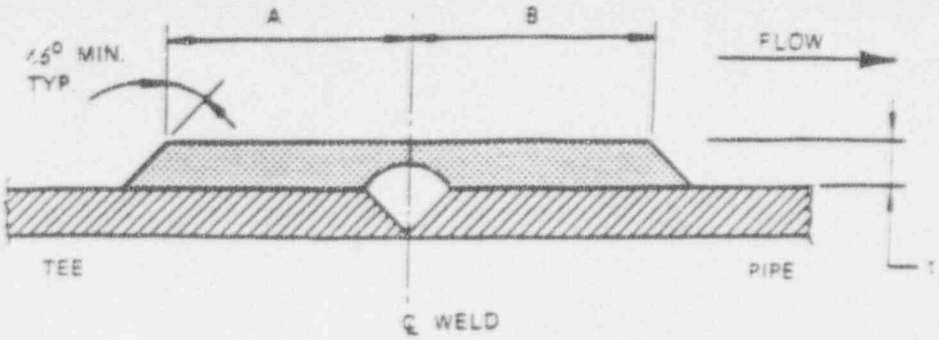
WELD OVERLAY REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
028S-S3	100% x 360°	0.42"	4.0"	4.0"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	[illegible] 6-30-86	CTS 6-30-86	[illegible] 6/30/86	[illegible] 6/30/86	[illegible] 6/30/86	

B NO:	PLANT:		SHT. 1	REV
CEC-47	QUAD CITIES UNIT 2	nutech	OF 1	0
FILE NO: CEC047.0228	DWG. NO: CEC-47-228			



WELD OVERLAY REPAIR DETAILS

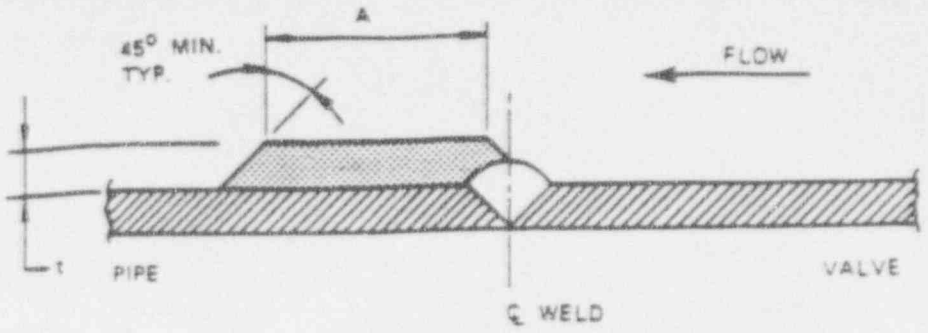
Patent applied for

(1) EXTEND OVERLAY AS FAR AS PRACTICAL TOWARD TEE HOWEVER "A" DIMENSION NEED NOT EXCEED 3.25".

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS			COMMENTS
		t	A	B	
10S-F1	100% x 360°	0.45"	(1)	3.25"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
0	[illegible] 6-30-86	CTS 6-30-86	[illegible] 6/30/86	[illegible] 6/30/86	[illegible] 6/30/86	

NO: CEC-47	PLANT: QUAD CITIES UNIT 2	nytech	SHT. 1 OF 1	REV 0
FILE NO: CEC047.0215	DWG. NO: CEC-47-215			



WELD OVERLAY
REPAIR DETAILS

Patent applied for

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS		COMMENTS
		A	t	
105-F5	100% x 360°	3.25"	0.45"	FULL STRUCTURAL WOR DESIGN

REV.	PREP. BY/ DATE	CHK. BY/ DATE	P.E. APPR./ DATE	E.M. APPR./ DATE	P.M. APPR./ DATE	DESCRIPTION
1	[illegible] 7-15-86	CTS 7-15-86	[illegible] 7/15/86	[illegible] 7/15/86	[illegible] 7/15/86	Revised A and t dimensions.
0	[illegible] 6-30-86	CTS 6-30-86	[illegible] 6/30/86	[illegible] 6/30/86	[illegible] 6/30/86	

J NO:	PLANT:		SHT. 1	REV.
CEC47	QUAD CITIES UNIT 2	nytech	OF 1	1
FILE NO: CEC047.0216	DWG. NO: CEC-47-216			

Appendix C

QUAD CITIES UNIT 2
SUSTAINED STRESSES AT UNFLAWED WELD LOCATIONS

NOTES:

(1) Internal pressure (IP) stress (psi) = $\frac{(P * OD)}{(4 * t_p)}$

where:

P	= Internal pressure (psi).
OD	= Outside diameter (in.)
t_p	= Pipe wall thickness (in.)

(2) DW, TH, and WOS stress = $\frac{F_X}{A} \pm \frac{\sqrt{M_Y^2 + M_Z^2}}{S}$

where:

DW	= Dead weight load/moments.
TH	= Thermal expansion load/moments.
WOS	= Weld overlay shrinkage load/moments,
F_X	= Axial load (lbs.)
M_Y or M_Z	= Bending moments (in.-lbs.)
A	= Metal cross-sectional area ($in.^2$)
S	= Metal section modulus ($in.^3$)

(3) Unless noted otherwise:

Total stress = |IP| + |DW| + |TH| + |WOS|.

(4) S_m = Allowable design stress intensity for Type 304 stainless steel at design temperature of 550°F per ASME Section III Appendices Table I-1.2.

(5) Stress ratio = (total stress) / S_m.

(6) Total stress = algebraic sum of IP + DW + TH + WOS.

Table C-1

QUAD CITIES UNIT 2
SUSTAINED STRESSES
REACTOR RECIRCULATION SYSTEM
12" RISERS

WELD NO.	IP STRESS (1) (psi)	DW STRESS (2) (psi)	TH STRESS (2) (psi)	WOS STRESS (2) (psi)	TOTAL STRESS (3) (psi)	S_m (4) (psi)	STRESS RATIO (5)
02C-F2	5800	1676	2128	11430	21033	16950	1.24
02C-S6	5800	562	4032	5640	16034	16950	0.95
02D-F2	5800	598	2096	19450	22856[6]	16950	1.35
02D-F6	5800	415	3239	438	9892	16950	0.58
02D-S4	5800	222	878	2871	9771	16950	0.58
02E-F2	5800	59	1979	7919	15756	16950	0.93
02E-F6	5800	331	1988	4841	12960	16950	0.76
02E-S4	5800	97	643	4281	10821	16950	0.64
02B-F6	5800	642	1134	1226	8802	16950	0.52
02F-F2	5800	76	704	526	7106	16950	0.42
02F-S4	5800	99	384	762	7045	16950	0.42
02G-F2	5800	724	2009	2214	10746	16950	0.63
02G-F6	5800	531	1265	3810	11406	16950	0.67
02H-F2	5800	554	1291	7413	15058	16950	0.89
02H-F6	5800	120	1918	5619	13457	16950	0.79
02J-F2	5800	388	715	6291	13194	16950	0.78
02K-F2	5800	240	841	7311	14193	16950	0.84
02L-F2	5800	140	757	17437	24133	16950	1.42
02L-F6	5800	709	1694	354	8556	16950	0.50
02M-F2	5800	810	1293	5042	12945	16950	0.76
02M-F6	5800	444	2135	3875	12253	16950	0.72

Table C-2

QUAD CITIES UNIT 2
SUSTAINED STRESSES
REACTOR RECIRCULATION SYSTEM
22" HEADER PIPING

WELD NO.	IP STRESS (1) (psi)	DW STRESS (2) (psi)	TH STRESS (2) (psi)	WOS STRESS (2) (psi)	TOTAL STRESS (3) (psi)	S_m (4) (psi)	STRESS RATIO (5)
02-F1	6290	109	864	182	7444	16950	0.44
02-F1D	6290	330	802	505	7926	16950	0.47
02-F1E	6290	547	737	773	8348	16950	0.49
02-F2	6290	687	671	1009	8657	16950	0.51
02A-F1	6290	149	844	665	7948	16950	0.47
02A-F5	6290	316	275	5904	12785	16950	0.75
02A-S3	6290	203	734	6009	13236	16950	0.78
02B-F1	6290	539	461	1475	8765	16950	0.52
02B-F5	6290	600	2273	703	9866	16950	0.58
02B-S7	6290	252	1727	542	8812	16950	0.52

Table C-3

QUAD CITIES UNIT 2
SUSTAINED STRESSES
REACTOR RECIRCULATION SYSTEM
28" PUMP SUCTION & DISCHARGE PIPING

WELD NO.	IP STRESS (1) (psi)	DW STRESS (2) (psi)	TH STRESS (2) (psi)	WOS STRESS (2) (psi)	TOTAL STRESS (3) (psi)	S_m (4) (psi)	STRESS RATIO (5)
02A-S4	6439	85	167	-146	6544	16950	0.39
02AD-F1	6439	384	368	226	7416	16950	0.44
02AD-F8	6439	123	73	557	7191	16950	0.42
02AD-F9	6439	339	148	145	7070	16950	0.42
02AD-S2	6439	390	320	854	8003	16950	0.47
02BD-F1	6439	342	1803	199	8783	16950	0.52
02BD-F12	6439	420	747	171	7777	16950	0.46
02BD-F9	6439	321	771	147	7677	16950	0.45
02BD-S1A	6439	76	105	135	6754	16950	0.40
02BD-S2	6439	384	1471	228	8521	16950	0.50
02AS-F2	7273	317	359	275	8224	16950	0.49
02AS-F5	7273	196	142	855	8467	16950	0.50
02AS-F8	7273	57	257	609	8196	16950	0.48
02AS-S3	7273	243	318	138	7972	16950	0.47
02AS-S6	7273	278	93	736	8381	16950	0.49
02BS-F14	7273	234	310	175	7993	16950	0.47
02BS-F2	7273	124	1872	318	9587	16950	0.57
02BS-F4	7273	384	219	355	8232	16950	0.49
02BS-F8	7273	131	1123	518	9046	16950	0.53
02BS-S5	7273	488	2978	602	11341	16950	0.67
02BS-S9	7273	231	228	371	8104	16950	0.48

Table C-4

QUAD CITIES UNIT 2
SUSTAINED STRESSES
SHUTDOWN COOLING SYSTEM

WELD NO.	IP STRESS (1) (psi)	DW STRESS (2) (psi)	TH STRESS (2) (psi)	WOS STRESS (2) (psi)	TOTAL STRESS (3) (psi)	S_m (4) (psi)	STRESS RATIO (5)
10S-F11	6062	476	2434	357	9329	16950	0.55
10S-F14A	6062	142	3349	650	10203	16950	0.60
10S-F15A	6062	508	1184	840	8595	16950	0.51
10S-F18	6062	716	250	0	7028	16950	0.41
10S-F4	6062	357	5971	706	13097	16950	0.77
10S-S12	6062	282	2084	249	8678	16950	0.51
10S-S13	6062	158	4860	632	11712	16950	0.69
10S-S17	6062	265	1064	0	7392	16950	0.44
10S-S19	6062	734	389	0	7186	16950	0.42
10S-S3	6062	461	2790	497	9809	16950	0.58
10S-S6	6062	332	5536	622	12552	16950	0.74
10S-S7	6062	198	1824	157	8241	16950	0.49
10S-S8	6062	105	2524	292	8983	16950	0.53
10S-S9	6062	304	2558	301	9225	16950	0.54
10S-F20	6062	294	887	0	7244	16950	0.43

Table C-5

QUAD CITIES UNIT 2
SUSTAINED STRESSES
RHR (LPCI) SYSTEM

WELD NO.	IP STRESS (1) (psi)	DW STRESS (2) (psi)	TH STRESS (2) (psi)	WOS STRESS (2) (psi)	TOTAL STRESS (3) (psi)	S_m (4) (psi)	STRESS RATIO (5)
LOOP A							
10AD-F1	6061	2814	11842	3008	23725	16950	1.40
10AD-F11	6061	695	755	2388	9898	16950	0.58
10AD-F12	6061	1321	5918	3767	17067	16950	1.01
10AD-F3	6061	917	7754	1223	15954	16950	0.94
10AD-F4	6061	372	3674	1754	11861	16950	0.70
10AD-F8	6061	651	9034	1259	17004	16950	1.00
10AD-S2	6061	271	3448	269	10049	16950	0.59
10AD-S5	6061	1248	8347	2149	17805	16950	1.05
10AD-S6	6061	864	7121	1349	15395	16950	0.91
10AD-S7	6061	109	1872	256	8398	16950	0.50
10AD-S9	6061	302	9325	161	15848	16950	0.93
LOOP B							
10BD-F1	6061	1057	12074	1071	20262	16950	1.20
10BD-F14	6061	290	2368	941	9660	16950	0.57
10BD-F15	6061	1328	4485	1524	13397	16950	0.79
10BD-F5	6061	605	6812	744	14222	16950	0.84
10BD-F6	6061	1272	5920	1004	14256	16950	0.84
10BD-S10	6061	105	2291	108	8564	16950	0.51
10BD-S11	6061	323	3944	288	10616	16950	0.63
10BD-S12	6061	744	6698	603	14105	16950	0.83
10BD-S13	6061	333	8290	59	14743	16950	0.87
10BD-S2	6061	310	2048	238	8657	16950	0.51
10BD-S3	6061	312	10203	232	16808	16950	0.99
10BD-S4	6061	279	8778	257	15374	16950	0.91
10BD-S7	6061	967	9479	1217	17724	16950	1.05
10BD-S8	6061	748	7503	739	15050	16950	0.89
10BD-S9	6061	57	7634	613	14364	16950	0.85

Table C-6

QUAD CITIES UNIT 2
SUSTAINED STRESSES
CORE SPRAY SYSTEM

WELD NO.	IP STRESS (1) (psi)	DW STRESS (2) (psi)	TH STRESS (2) (psi)	WOS STRESS (2) (psi)	TOTAL STRESS (3) (psi)	S_m (4) (psi)	STRESS RATIO (5)
LOOP A							
14A-F10R	5665	274	2398	0	8336	16950	0.49
14A-F12	5665	279	5124	0	11068	16950	0.65
14A-F13	5665	467	3391	0	9523	16950	0.56
14A-F17	5665	101	6911	0	12678	16950	0.75
14A-F2	5665	601	6296	0	12562	16950	0.74
14A-F4R	5665	552	5587	0	11804	16950	0.70
14A-S1	5665	795	8255	0	14715	16950	0.87
14A-S11	5665	217	1232	0	7114	16950	0.42
14A-S14	5665	120	2958	0	8743	16950	0.52
14A-S15	5665	281	2423	0	8369	16950	0.49
14A-S16	5665	340	6249	0	12254	16950	0.72
LOOP B							
14B-F11R	5665	264	1748	0	7678	16950	0.45
14B-F13	5665	240	3022	0	8927	16950	0.53
14B-F14	5665	598	3280	0	9544	16950	0.56
F14B-F14AR	5665	756	3784	0	10204	16950	0.60
14B-F16	5665	184	7113	0	12962	16950	0.76
14B-F2	5665	472	3377	0	9513	16950	0.56
14B-F4R	5665	783	2287	0	8736	16950	0.52
14B-S1	5665	69	6068	0	11801	16950	0.70
14B-S12	5665	275	708	0	6648	16950	0.39
14B-S15	5665	286	6905	0	12856	16950	0.76
14B-S8R	5665	328	6993	0	12986	16950	0.77

Appendix D

EVALUATION OF WELD 02J-S3 OVERLAY BOAT SAMPLE

SYSTEM MATERIALS ANALYSIS DEPARTMENT REPORT
ON
02J-S3 RISER WELD OVERLAY BOAT SAMPLE
FROM
QUAD CITIES STATION UNIT 2

During the R10 outage of Quad Cities Station Unit 2, an ultrasonic inspection of the overlay on 02J-S3 riser weld, elbow side, revealed axial cracks extending into the overlay. As a result of the apparent crack extension into the overlay, a boat sample was removed which captured the deepest crack penetration into the overlay. This boat sample was metallurgically examined to verify the depth of crack penetration into the overlay and to identify the mechanism of cracking. Based on this analysis, no crack penetration into the weld overlay occurred. Evidently, the UT sizing of the crack (remaining ligament) was overly conservative. One axially oriented IGSCC type crack was observed which terminated at the base metal-weld metal overlay interface.

NDE Inspection Background

During the R9 outage in 1988, GAPCo applied an overlay to the 02J-S3 riser weld due to an axial crack indication. The overlay thickness was approximately 0.3". Upon completion of the overlay a baseline UT inspection, performed by General Electric, revealed two axial indications terminating at or near the fusion line of the overlay. Reinspection of the overlay during the R10 outage by Lambert, McGill and Thomas (LMT) revealed two axial indications. One of the axial indications was reported to have a remaining ligament of 0.12". The other indication had a remaining ligament of 0.45". SMAD NDE personnel also inspected the overlay and

reported two axial flaws approximately 1/2" apart with the deepest penetration resulting in a remaining ligament between 0.11" to 0.25". The other axial indication was not in the overlay. Both WT and SMAD personnel located and marked the area where the thinnest ligament (deepest crack penetration into the overlay) was observed. This area was then captured in a boat sample for further analysis.

Metallugrical Analysis

The as-received boat sample was visually examined. Two punch marks approximately 1/2" apart were on the boat sample. The NDE personnel reported the thinnest remaining ligament was located between the two punch marks. The boat was approximately 3" long, 3/4" wide and 0.383" deep.

Based on the location of the punch marks, five different cross sections through the boat sample were metallographically prepared and examined. The deepest crack observed was in the first cross section examined. An intergranular crack was observed in the base metal directly beneath the fusion line of the overlay. The crack was in the center of the material captured by the sample. Figure 1 is a photomicrograph of the crack. Note that the crack stops at the fusion line and does not penetrate into the weld metal overlay. Figure 2 is a closer view of the crack which terminates at the fusion line. Examination of the other cross sections showed the crack to be either further from the fusion line or not present. This indicates that the deepest crack penetration (which is synonymous with the thinnest remaining ligament) did not penetrate into the weld overlay. The measured remaining ligament was 0.27", the thickness of the overlay at that location. In other cross sections, the overlay was measured to be as thick as 0.35".

Metallographic examination of the weld metal was performed in the unetched and etched conditions. This was done to identify any possible sources of a UT reflector. No evidence of any welding related defect was observed. Figure 3 is a photomicrograph of the weld metal microstructure. The delta ferrite content of the weld was determined with the aid of a computer enhanced image analyzer The average delta ferrite content was 12.7%.

Conclusion

Based on this analysis and conversations with the inspection personnel, the flaw which was reported to be in the weld overlay was not found and implies the indication was over-sized. The determination of the remaining ligament was overly conservative. No evidence of defects such as, cracks, lack of fusion, porosity, or lag were found. The thinnest remaining ligament which should have been measured was 0.27", the minimum thickness of the overlay at that location.

Approved by: _____ Reported by: _____

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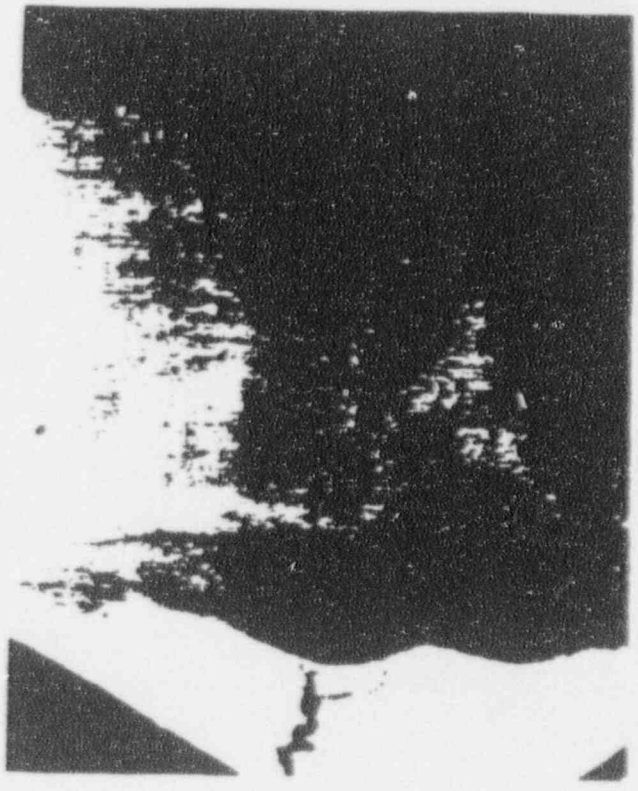
12.1.4

2837M-1



11.25X Magnification

10% Oxalic Acid
Electrolytic

Figure 1. Boat sample cross section showing the crack terminating at the fusion line of the overlay.

283/M-4

150X Magnification

10% Oxalic Acid
Electrolytic

Figure 2. Magnified view of the crack in Figure 1. Note that the crack extends to the fusion line but does not progress any further.

2837M-5

300X Magnification

10% Oxalic Acid
Electrolytic

Figure 3. The typical weld metal microstructure. The delta ferrite content of the weld was determined to be 12.7% using a computer enhanced image analyzer.