COMMONWEALTH EDISON COMPANY
CALCULATION TITLE PAGE

CALCULATION NO. NED-P-MSD-088 PAGE NO.: 1

X SAFETY RELATED _____ REGULATORY RELATED _____ NON-SAFETY RELATED

CALCULATION TITLE: Flaw Evaluation for 02AD-F12 Weld in Quad Cities Unit 1 Loop A Recirculation System

STATION/UNIT: Quad Cities Unit 1 SYSTEM ABBREVIATION: RR

EQUIPMENT NO.: (IF APPL.) PROJECT NO.: (IF APPL.)

REV: 0 STATUS: QA SERIAL NO. OR CHRON NO. 214805 DATE: 3/11/96

PREPARED BY: Guy H. DeBoo Guy H. DeBoo DATE: 3/11/96

REVISION SUMMARY: Initial Issue

ELECTRONIC CALCULATION DATA FILES REVISED:
(Name ext/size/date/hour: min/verification method/remarks)

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION YES _____ NO X

REVIEWED BY: Hien Q. Do Hien Q. Do DATE: 3/11/96

REVIEW METHOD: Detailed review. COMMENTS (C OR NC): NC

APPROVED BY: Guy H. DeBoo Guy H. DeBoo DATE: 3/11/96

COMMONWEALTH EDISON COMPANY
CALCULATION TITLE PAGE

CALCULATION NO. NED-P-MSD-088 PAGE NO.: 2

REV: STATUS: QA SERIAL NO. OR CHRON NO. DATE:_____

PREPARED BY: _____ DATE:_____

REVISION SUMMARY:

ELECTRONIC CALCULATION DATA FILES REVISED:
(Name ext/size/date/hour: min/verification method/remarks)

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION YES_____NO____

REVIEWED BY: _____ DATE:_____

REVIEW METHOD: COMMENTS (C OR NC): _____

APPROVED BY: _____ DATE:_____

ELECTRONIC CALCULATION DATA FILES REVISED:
(Name ext/size/date/hour: min/verification method/remarks)

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION YES_____NO____

REVIEWED BY:_____ DATE:_____

REVIEW METHOD: COMMENTS (C OR NC):_____

APPROVED BY:_____ DATE:_____

REVIEWED BY:_____ DATE:_____

REVIEW METHOD: COMMENTS (C OR NC):_____

APPROVED BY:_____ DATE:_____

COMMONWEALTH EDISON COMPANY
CALCULATION TABLE OF CONTENTS

	PROJECT NO.	
CALCULATION NO.NED-P-MSD-088	REV. NO. 0	PAGE NO. 3
DESCRIPTION	PAGE NO.	SUB-PAGE NO.

Purpose/Objective:

The purpose of this calculation is to evaluate the flaws detected in weld 02AD-F12 on Quad Cities Unit 1 Recirculation A loop pump discharge line. These flaws were found during the augmented IGSCC inspection program, which is based on NRC GL-88-01. The flaws exceeded the applicable acceptance standards for austenitic steels delineated in IWB-3514 of the 1989 ASME Section XI Code, Reference 1, and are evaluated using the methodology and acceptance criteria specified in Reference 1, IWB-3640, to establish their acceptance for continued service.

Methodology and Acceptance Criteria:

The piping report, Reference 4, identify the material used for the piping containing the flaws as SA358 Gr 304 austenitic stainless steel. Therefore, the evaluation and acceptance requirements of IWB-3640 are applicable to the evaluation of these flaws. The rules of IWB-3641 of ASME Section XI, 1989 Edition are applicable because the following conditions are met:

(a) Piping/fitting NPS ≥ 4 with the flaw within $\sqrt{rt}$ of the weld.

(b) Piping/fitting materials are made of wrought stainless steel, Ni-Cr-Fe alloy.

(c) Materials have a specified minimum yield strength less than 45 ksi.

(d) Material S_m values are given in Table I-1.2 of Section III, 1989 Edition.

As required in IWB-3641 of Reference 1, flaw growth analyses are performed on the flaws to determine their maximum growth due to fatigue and stress corrosion cracking mechanisms for an evaluation period of at least four (4) operating years (35040 hours). The calculated maximum flaw dimensions at the end of the evaluation period (i.e., 4 years) are compared with the calculated maximum allowable flaw dimensions for both normal operating/upset conditions and emergency/faulted conditions to determine the acceptability for continued service.

The flaw growth analyses are performed for fatigue crack growth following the methodology of Reference 1 Appendix C and for IGSCC following the methodology of NUREG-0313, Reference 6. The fatigue crack growth is based on the normal/upset operating events expected to occur during the evaluation period with the transient definition and transient stresses developed for Dresden Unit 3 Recirculation system used in this evaluation. The IGSCC crack growth rate is developed using the residual stress distribution and operating loads with the da/dt relationship defined in Appendix A of Reference 6. The evaluation period for the flaw growth analyses was determined as the time necessary for the flaw depth to grow to approximately the IWB-3640 acceptable depth limit.

The bounding normal/upset and emergency/faulted design basis load combinations are used to define the applied stress values used in this evaluation. These bounding applied stress values are used to establish the acceptable crack size which must be greater than the end of evaluation flaw size. Because these flaws are located adjacent or within the weld material as defined in Figure IWB-3641-1 of Reference 1, the critical flaw size is defined using the criteria for a submerged arc weld,SAW.

Assumptions:

1) Quad Cities Unit 1 and Dresden Unit 3 recirculation system pressure and thermal transient responses to normal/upset transient events are identical. This is a reasonable assumption because both units are fabricated from materials with identical material properties for thermal expansion and identical fitting geometries and are operated using similar procedures.

2) The welding process used to fabricate this weld is conservatively defined as SAW, submerged arc weld.

3) Five startup/shutdown events were assumed to occur during the evaluation period with a single idle loop restart occurring between each startup and shutdown. While this places some limitation on operation over the next fuel cycle, the fatigue crack growth studies show that fatigue crack growth is minimal. Thus, this limitation can be reevaluated if the 5 cycle limit is approached.

Design Input:

Flaw Characterization:

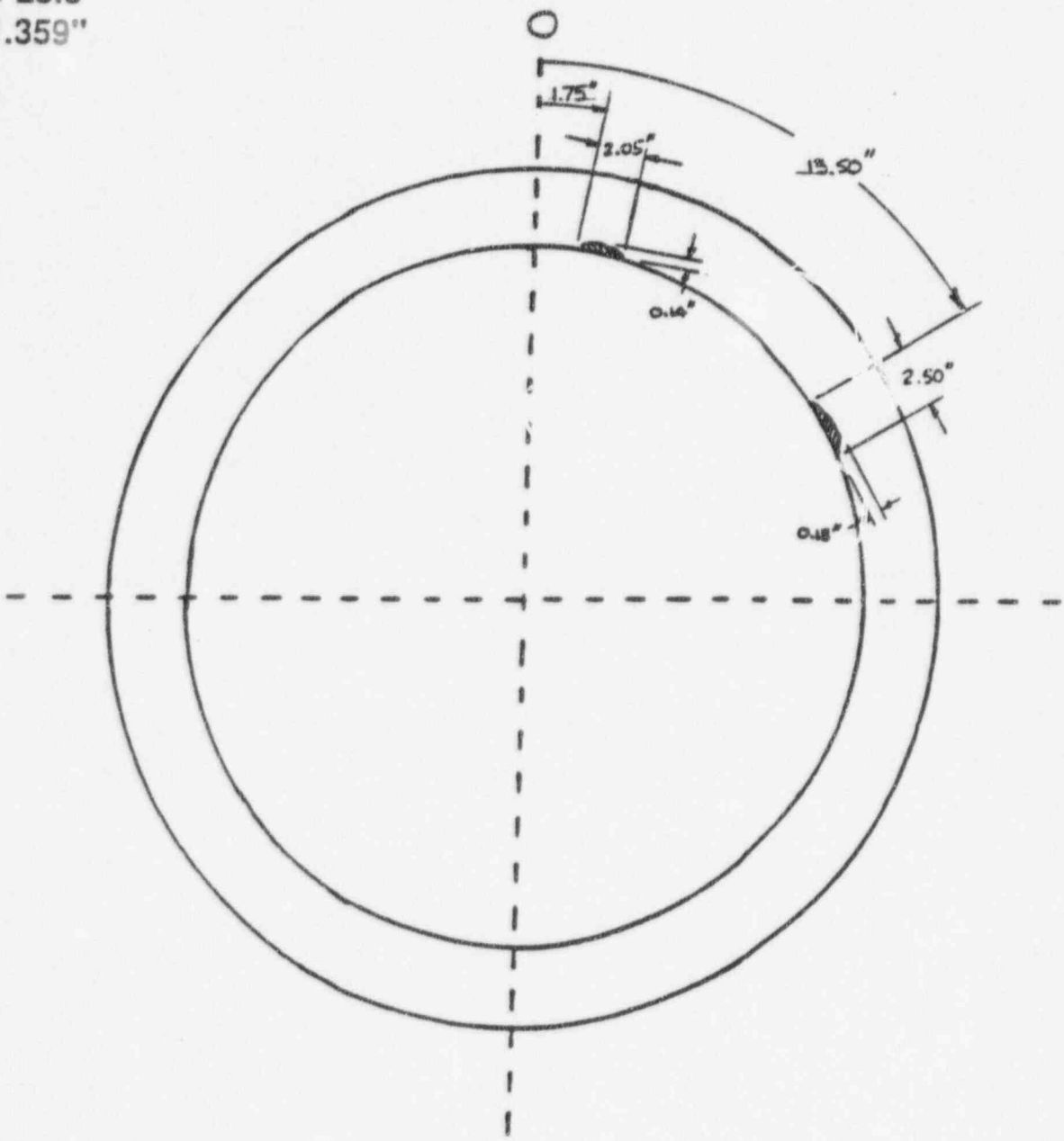
Weld 02AD-F12 (Reference 3) contains the following circumferentially oriented flaws in the 28" OD pipe to pump nozzle weld of the loop A recirculation pump discharge. A cross-section of this weld is provided in Figure 1.

Flaw No.	Depth	Length	Circumferential Location Clockwise from Top
1	0.140"	2.05"	1.75"
2	0.180"	2.50"	13.50"

These flaws are located on the pipe side of the weld and are ID connected. The nominal wall thickness, used in this evaluation, is 1.359".

Figure 1 Weld 02AD-F12

OD 28.0"
t=1.359"



Loading .

Input data for the piping beam type loads is provided in Reference 5. The loads provided are deadweight (WT), thermal and OBE seismic (OBE). In accordance with the Quad Cities FSAR, SSE is twice OBE. The loads provided are the axial force and bending moments at the weld. Input data for pressure and temperature are taken from the Class 1 piping calculations for Dresden Unit 3, Reference 7.

Weld 02AD-F12 Loop A Recirculation Pump Discharge:
Maximum Temperature = 550°F Maximum Pressure = 1185 psi

	Fa (lbf)	Mb (ft-lbf)	Mc (ft-lbf)
Weight	-1866	-2629	-27683
Thermal	2046	34995	-32166
OBE	1695	6688	16324

Fatigue Load Definition:

The normal/upset design basis transient events are defined in Reference 7 for this line. The thermal gradients defined for this line are zero except for the restart of an idle recirculation loop. Using an as welded tapered transition weld, the Reference 7 thermal transients temperatures for these events are:

	ΔT_1(°F)	ΔT_2(°F)	T_a(°F)	T_b(°F)
Restart	-44.75	-27.01	513.72	533.93

Materials:

As defined in Reference 3, the flaws are located on the pipe side of the weld. The material for this piping is SA358 Gr 304. From Reference 2, S_m for this material is 16,900 lbs/in^2 at 550°F. The following material properties at 500°F are used in the evaluations:

$$E = 25.8 \times 10^6 \text{ psi}$$
$$\alpha = 9.4 \times 10^{-6} \text{ in/in/°F}$$
$$\nu = 0.3$$

The use of E and α at 500°F (vs. 534 or 357°F) will not affect the conclusions reached for the fatigue crack growth.

References:

1) ASME Boiler and Pressure Vessel Code, Section XI, 1989 Edition.

2) ASME Boiler and Pressure Vessel Code, Section III, 1989 Edition.

3) LMT NDE Report Transmitting Ultrasonic Data Sheets for weld 02AD-F12 at Quad Cities Unit 1, dated 3/7/96.

4) ABB Reactor Recirculation Piping Report, Q1-RRCI-01C, Revision 14, EMD-067693.

5) NDIT S040-QH-0262-00 from Sargent & Lundy to ComEd (L. Kaushansky to G. H. DeBoo), dated 3/8/96.

6) "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping", NUREG-0313, Revision 2, January 1988.

7) ABB Impell Corporation Calculation D3-RRCI-RP01, "Recirculation Loop A - Piping Replacement", Dresden Unit 3, Revision 11, 3/7/95, (1591-00591).

8) PC-CRACK, Fracture Mechanics Software, Version 2.1 Structural Integrity Associates, Inc.

9) "Ductile Fracture Handbook", Volume 2, NP-6301-D, EPRI,October1990.

Calculations:

Evaluation of Loop A Recirculation Pump Discharge Weld 02AD-F12:

Piping Dimensions and Material Properties for Loop A Recirculation Pump Discharge Weld 02AD-F12:

Outside Diameter, D_o: $D_o := 28.0 \cdot in$

Measured Wall Thickness, t_n: $t_n := 1.359 \cdot in$ $\quad R := \frac{D_o - t_n}{2}$

Axial Area, A: $A := \pi \cdot \frac{D_o^2 - (D_o - 2 \cdot t_n)^2}{4}$ $\quad A = 113.7 \cdot in^2$

Section Modulus, Z: $Z := \pi \cdot \frac{D_o^4 - (D_o - 2 \cdot t_n)^4}{64 \cdot \frac{D_o}{2}}$ $\quad Z = 722.7 \cdot in^3$

S_m at Operating Temperature. $S_m := 16900 \cdot psi$ at 550 °F

Modulus of Elasticity: $E := 25.8 \cdot 10^6 \cdot psi$

Coefficient of Thermal Expansion: $\alpha := 9.4 \cdot 10^{-6} \cdot \frac{in}{(in \cdot F)}$

Poisson Ratio: $\nu := 0.3$

Load Definition and Stress Calculation for Loop A Recirculation Pump Discharge Weld 02AD-F12:

Axial Forces (lbs and psi):

Normal and Upset Condition Pressure, P_n: $P_n := 1185.0 \cdot psi$

Emergency and Faulted Condition Pressure, P_f: $P_f := 1185.0 \cdot psi$

$$\sigma_{Pn} := \frac{P_n \cdot D_o}{4 \cdot t_n} \qquad \sigma_{Pn} = 6103.8 \cdot psi$$

$$\sigma_{Pf} := \frac{P_f \cdot D_o}{4 \cdot t_n} \qquad \sigma_{Pf} = 6103.8 \cdot psi$$

Weight Axial Force, W: $W := 1866 \cdot lbf$ $\quad \sigma_{Wm} := \frac{W}{A} \qquad \sigma_{Wm} = 16.4 \cdot psi$

Thermal Axial Force, T: $T := 2046 \cdot lbf$ $\quad \sigma_{Tm} := \frac{T}{A} \qquad \sigma_{Tm} = 18 \cdot psi$

Seismic Axial Force

OBE Force, F_{OBE}: $F_{OBE} := 1695 \cdot lbf$ $\quad \sigma_{OBEm} := \frac{F_{OBE}}{A} \qquad \sigma_{OBEm} = 14.9 \cdot psi$

SSE Force, F_{SSE}: $F_{SSE} := 2 \cdot F_{OBE}$ $\quad \sigma_{SSEm} := \frac{F_{SSE}}{A} \qquad \sigma_{SSEm} = 29.8 \cdot psi$

Bending Moments (in-lbs):

Weight, M_w: $M_w := 12 \cdot \left(2629^2 + 27683^2\right)^{\frac{1}{2}} \cdot in \cdot lbf$ $\quad \sigma_{Wb} := \frac{M_w}{Z} \qquad \sigma_{Wb} = 461.8 \cdot psi$

Thermal, M_T:

$M_T := 12 \cdot \left(34995^2 + 32166^2\right)^{\frac{1}{2}} \cdot in \cdot lbf$ $\sigma_{Tb} := \frac{M_T}{Z}$ $\sigma_{Tb} = 789.3 \cdot psi$

Seismic Moments:

OBE, M_{OBE}:

$M_{OBE} := 12 \cdot \left(6688^2 + 16324^2\right)^{\frac{1}{2}} \cdot in \cdot lbf$ $\sigma_{OBEb} := \frac{M_{OBE}}{Z}$ $\sigma_{OBEb} = 292.9 \cdot psi$

SSE, M_{SSE}:

$M_{SSE} := 2 \cdot M_{OBE}$ $\sigma_{SSEb} := \frac{M_{SSE}}{Z}$ $\sigma_{SSEb} = 585.9 \cdot psi$

Thermal Transient Stress for Fatigue Crack Growth of the Loop A Recirculation Pump Discharge Weld 02AD-F12:

Restart of Idle Loop:

$\Delta T_1 := 45.4 \cdot F$ $\Delta T_2 := 30.83 \cdot F$

Linear Through wall Bending Stress: $\sigma_{\Delta T1} := \frac{E \cdot \alpha \cdot \Delta T_1}{2 \cdot (1 - \nu)}$ $\sigma_{\Delta T1} = 7864.6 \cdot psi$

Non-Linear (skin effect) Bending Stress, ΔT_2: Because this event generates a compressive stress on the inner surface this stress will be ignored.

Gross Discontinuity Bending Stress: Because this flaw is not at gross structural discontinuity the T_a - T_b stress is not applicable to this evaluation.

Piping Membrane and Bending Stress for Crack Growth of the Loop A Recirculation Pump Discharge Weld 02AD-F12:

Normal and Upset Conditions:

$P_{mn} := \sigma_{Pn} + \sigma_{Wm} + \sigma_{Tm}$ $\quad P_{mn} = 6138.1 \cdot psi$

$P_{bn} := \sigma_{Wb} + \sigma_{Tb}$ $\quad P_{bn} = 1251 \cdot psi$

For Fatgue and IGSCC Crack Growth the total Membrane plus Bending stress is used as a membrane stress for conservatism:

$$P_{mn} + P_{bn} = 7389.2 \cdot psi$$

Axial Residual Stress Through Wall Distribution for the Loop A Recirculation Pump Discharge Weld 02AD-F12:

Residual Stress Through Wall Distribution per NRC NUREG-0313 Rev 2 to be used for the crack growth calculations:

$\sigma_0 := 1.0$ $\quad \sigma_i := 30000.0 \cdot psi$

$\sigma_1 := -6.910$

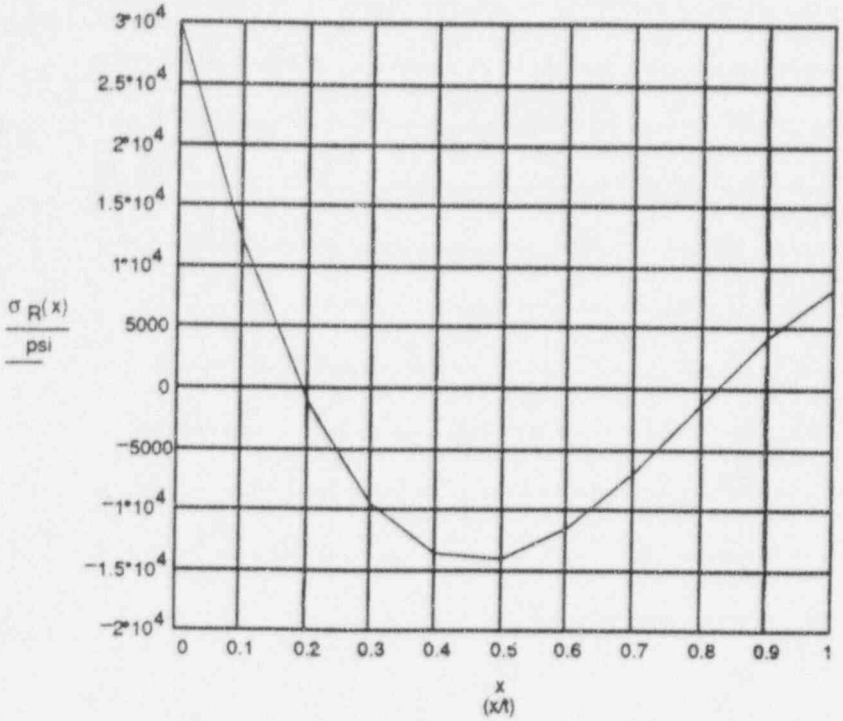
$\sigma_2 := 8.687$

$\sigma_3 := -0.480$

$\sigma_4 := -2.027$

$$\sigma_R(x) := \sigma_i \cdot \left[\sigma_0 + \sigma_1 \cdot (x) + \sigma_2 \cdot (x)^2 + \sigma_3 \cdot (x)^3 + \sigma_4 \cdot (x)^4\right]$$

$x := 0.0, 0.1 .. 1.0$ This is the through wall ratio x/t



x	σ R(x) / psi
0	30000
0.1	11855.6
0.2	-1248.1
0.3	-9616.5
0.4	-13700.7
0.5	-14098.1
0.6	-11551.8
0.7	-6950.8
0.8	-1330.2
0.9	4129.1
1	8100

Axial Residual Stress Distribution

IGSCC Crack Growth Calculation for the Loop B Recirculation Pump Discharge Weld 02AD-F12:

The crack growth due to IGSCC is calculated using the previously calculated residual stress and the combined pressure, weight and thermal stresses acting on the present flaw depth of 0.180" and 0.140" for a 360° circumferential flaw. The crack growth rate, $da/dt = 3.590 \times 10^{-8} K_I^{2.161}$ in/hour, specified in NUREG-0313, Reference 6, was used to project the flaw depth. The calculations, documented in Attachment C, were performed using the PC-CRACK program, Reference 8.

After 44000 hours, the deepest flaw grows from 0.180" to a depth of 0.662" as a result of stress corrosion crack growth which produces an a/t ratio of 0.49. As recommended in NUREG-0313, Reference 6, the flaw length is projected by increasing the original aspect ratio, l/a, by the factor that the depth has increased to calculate the projected aspect ratio. The flaw lengths for the two flaws are projected below.

$a_1 := 0.140 \cdot in \quad l_1 := 2.05 \cdot in \quad a_{1f} := 0.650 \cdot in \quad l_{1f} := \frac{l_1}{a_1} \cdot \frac{a_{1f}}{a_1} \cdot a_{1f} \quad l_{1f} = 44.2 \cdot in$

$a_2 := 0.180 \cdot in \quad l_2 := 2.50 \cdot in \quad a_{2f} := 0.662 \cdot in \quad l_{2f} := \frac{l_2}{a_2} \cdot \frac{a_{2f}}{a_2} \cdot a_{2f} \quad l_{2f} = 33.8 \cdot in$

Based on the proximity of these flaws and their projected length, these flaws will connect to form a single flaw. The projected length of the single flaw will extend 53.25" after 44000 hours of operation. Because the projected flaw length exceeds 30% of the circumference, the flaw is treated as a single 360° circumferential flaw, as directed in NUREG-0313.

Fatigue Crack Growth Calculation for the Loop A Recirculation Pump Discharge Weld 02AD-F12:

The fatigue crack growth is calculated using the previously calculated thermal transient stress, the residual stress and the combined pressure, weight and thermal stresses. The range sets defined for this evaluation include 5 startup and shutdown events with 1 idle loop restart event occurring during each startup and shutdown cycle. The fatigue crack growth was calculated using the PC-CRACK program, Reference 8, and the fatigue crack growth rate specified in Appendix C of Reference 1. The fatigue crack growth was based a 360° circumferential flaw model with two initial crack depths: The projected end of evaluation period flaw depth rounded up to 0.665" and the current deepest flaw depth of 0.180" to establish the bounding fatigue crack growth condition. These calculations are documented in Attachment D.

A review of these evaluations shows that the fatigue crack growth for both initial flaw depths is insignificant and therefore does not contribute to the final end of evaluation period flaw size.

ASME Section XI Acceptance Criteria for the Loop A Recirculation Pump Discharge Weld 02AD-F12:

After 44000 operating hours (5 years) the flaw size has been projected to be a maximum 0.662" in depth for the full circumference of the weld.

The following calculations determine the code acceptable flaw size for the bounding normal/upset load combination and the bounding emergency/faulted load combination.

Table IWB-3641-5 For Submerged Arc Welds (SAW), Applied Stress Ratio:

Piping Membrane Stress for the Loop A Recirculation Pump Discharge Weld 02AD-F12:

Normal and Upset Conditions:

$P_{mn} := \sigma_{Pn} + \sigma_{Wm} + \sigma_{OBEm} + \sigma_{Tm}$ $\qquad P_{mn} = 6153 \cdot psi$

Emergency and Faulted Conditions:

$P_{mf} := \sigma_{Pf} + \sigma_{Wm} + \sigma_{SSEm} + \sigma_{Tm}$ $\qquad P_{mf} = 6168 \cdot psi$

Piping Bending Stress Loop A Recirculation Pump Discharge Weld 02AD-F12:

Normal and Upset Conditions:

$P_{bn} := \sigma_{Wb} + \sigma_{OBEb}$ $\qquad P_{bn} = 754.7 \cdot psi$

Emergency and Faulted Conditions:

$P_{bf} := \sigma_{Wb} + \sigma_{SSEb}$ $\qquad P_{bf} = 1047.6 \cdot psi$

Thermal Expansion Stress:

$P_e := \sigma_{Tb}$ $\qquad P_e = 789.3 \cdot psi$

Applied Stress Ratio in SAWs for the Normal/Upset Condition per Table IWB-3641-5:

$$M := 1.08 + 0.009 \cdot \left(\frac{D_o}{in} - 24 \right) \qquad M = 1.116$$

$$SR_n := M \cdot \frac{P_{mn} + P_{bn} + \frac{P_e}{2.77}}{S_m} \qquad SR_n = 0.475$$

From Table IWB-3641-5 the acceptable a/t ratio for a flaw length equal to or greater than 50% of the circumference and an applied stress ratio of 0.60 or less is 0.49, therefore the acceptable flaw depth, a_{nc}, for the normal/upset conditions is

$$a_{nc} := 0.49 \cdot t_n \qquad a_{nc} = 0.666 \cdot in$$

which is greater than the projected end of evaluation period flaw depth of $a_{2f} = 0.662 \cdot in$

Applied Stress Ratio in SAWs for the Emergency/Faulted Condition per Table IWB-3641-6:

$$SR_f := M \cdot \frac{P_{mf} + P_{bf} + \frac{P_e}{1.39}}{S_m} \qquad SR_f = 0.514$$

The smallest stress ratio given Table IWB-3641-6 is 1.2 which is significantly greater than the applied stress ratio of 0.514, therefore application of the IWB-3641-6 table would significantly underestimate the acceptable flaw depth , a_{fc}, for the emergency/faulted condition.

To demonstrate that the acceptable flaw depth for the emergency/faulted condition is greater than a_{nc} for the normal/upset condition, the methodology provided Appendix C of Reference 1 is used to define the appropriate safety factor and Z factor for flaws in SAWs.

ASME Safety Factor:

Normal and Upset Conditions:

$SF_n := 2.77$

Emergency and Faulted Conditions:

$SF_f := 1.39$

For SAW ASME Code Z Factor:

SAW:

$$Z_{saw} := 1.30 \cdot \left[1 + 0.010 \cdot \left(\frac{D_o}{1 \cdot in} - 4 \right) \right] \qquad Z_{saw} = 1.612$$

Because the membrane stress, $P_{mf} = 6168 \cdot psi$ is greater than the bending stress, $P_{bf} = 1047.6 \cdot psi$ the limit load for tension is calculated using the formula specified in Reference 9. The applied tensile stress is calculated by conservatively adding the bending stress to the membrane stress, multiplying the appropriate stress by the required safety factor and multiplying the total stress by the Z factor for SAWs.

Tensile Limit Load from Reference 9 using a flaw depth equal to the normal/upset limit:

$$P_l := \left(2 \cdot \frac{\pi}{\sqrt{3}}\right) \cdot 3 \cdot S_m \cdot \left[\left(\frac{D_o}{2}\right)^2 - \left(\frac{D_o}{2} - t_n + a_{nc}\right)^2\right]$$

The limiting tensile stress for a 360° circumferential flaw with depth of 0.666" for the emergency/faulted condition is:

$$\frac{P_l}{A} = 30603.4 \cdot psi$$

The applied tensile stress for the emergency/faulted condition is:

$$\left[\left(P_{mf} + P_{bf}\right) \cdot 1.39 + P_e\right] \cdot Z_{saw} = 17440.1 \cdot psi$$

The applied tensile stress of 17440.1 psi is significantly less than the limiting stress of 30603.4 psi for a 360° flaw 0.666" deep, therefore the normal/upset condition is limiting and the acceptable flaw depth is $a_{nc} = 0.666 \cdot in$

Summary and Conclusions:

The evaluation for the multiple flaws found in the 02AD-F12 weld of the Loop A Recirculation Pump discharge line is acceptable for 44000 hours of hot operating time. This evaluation was performed using methodology and acceptance criteria of IWB-3640 of the ASME B&PV Code, Section XI, Reference 1. The end of evaluation period flaw sizes considered crack growth from IGSCC and fatigue mechanisms, and calculated the IGSCC growth as specified in NUREG-0313, Reference 6. The end of evaluation period flaw depths were shown to be less than the acceptable flaw depth for a 360° circumferential flaw.

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Main Office
525 Aldo Avenue
Santa Clara, CA 95054-2205
408/980-9333

DATE: 3-07-96
TO: DAVE WEBB-CECO-EXT 3054:
FROM: RICK MAY - LMT-EXT 3255:
RE: TRANSMITTAL OF COMPLETED NDE REPORTS: #8

NO	SYS	WELD	DATE	TYPE	L-XXX	C-XXX	R-XXX	RESULTS:
1	RR	02AD-F12	2-21-96	PT			R-028	ACCEPT
			3-5-96	UT			R-058	RI, TWO LINEARS, LIMITED E>
			3-6-96	UT	L-020		R-063	RI, 1 MEASURABLE
								1 , <= 10% THRU-WALL.

KEY----------

DATE = DATE OF EXAM
TYPE = TYPE NDE; MT, PT or UT
L-XXX = UT INSTRUMENT LINEARITY REPORT NO.
C-XXX = UT INSTRUMENT CALIBRATION REPORT NO.
R XXX = NDE REPORT NO.
RESULTS:
ACC = ACCEPT PER MT/PT PROCEDURE
REJ = REJECT PER MT/PT PROCEDURE
NI = NO INDICATION PER UT PROCEDURE
NRI = NO RECORDABLE INDICATION PER PROCEDURE
RI = RECORDABLE INDICATION PER PROCEDURE
ID = INSIDE DIAMETER
OD = OUTSIDE DIAMETER
GEO = GEOMETRY, PART OF THE COMPONENT CONFIGURATION

FORM NDT-D-2-F1

LIQUID PENETRANT EXAMINATION DATA SHEET

DATE: 2-21-96 STATION & UNIT: QUAD #1 Q1R14 DATA SHEET# R-028

EXAMINER: R.L. MAY / T.W. THOMAS LEVEL: III / II

SYSTEM: RECIRC. "A" DISCHARGE MATERIAL: SS

COMPONENT: LINE # 1-0201A-28" / PIPE - PUMP (1 SEAM WELD) / WELD # 02AD-F12

SECTION XI EDITION & ADDENDA: 1989 EDITION CODE CLASS: 1

SECTION XI CATEGORY: B-J ACCEPTANCE STD.: IWB-3514

PROCEDURE # & REVISION: NDT-D-2 REV. 10 SKETCH SHEET USED: YES NA NO ✓

COMMENTS: EXAMINED 100% AS PER PROCEDURE. PREVIOUS EXAM RESULTS WERE NOT AVAILABLE.

LIQUID PENETRANT EXAM:

MATERIAL:
MATERIAL MANUFACTURE: MAGNAFLUX

	TYPE	BATCH			
PRE-EXAM CLEANER:	SKC-S	95E14K	DRYING	5	MINUTES
PENETRANT:	SKL-SP	94L05K	PENETRATION	10	MINUTES
PENETRANT CLEANER:	SKC-S	95F14K	DRYING	5	MINUTES
DEVELOPER:	SKD-S2	95J10K	DEVELOPING	7	MINUTES
POST EXAM CLEANER:	SKC-S	95F14K			

SURFACE TEMPERATURE: 96°F LIGHT SOURCE: FLASHLIGHT

EXAMINATION RESULTS:

ACCEPT ✓ REJECT NA

REVIEWED BY:

EXAMINER: R.L. MAY / T.W. THOMAS LEVEL: III / II DATE: 2-21-96

LMT REVIEWER: J.M. Johnson / J.M. Johnson LEVEL: II DATE: 2-21-96

OTHER: LEVEL:

STATION:

ANII:

Attachment A
NED-P-MSD-088
Revision 0
A2

ULTRASONIC CALIBRATION FORM NDT-CF-C2

STATION/UNIT: QUAD CITIES 1, Q1F14 PAGE: 1 OF 2

PROCEDURE: NDT- C.2 REV. 22 CALIBTATION SHEET # C-027 DATE: 03.05.96

EXAMINATION METHOD
STRAIGHT BEAM: N/A ANGLE BEAM: axial ✓ circumferential ✓

LINEARITY SHEET NO. L.019

CALIBRATION BLOCK
CALIBRATION STANDARD NUMBER: 99975QC THICKNESS: 1.361"

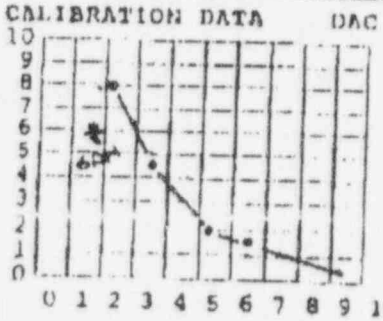
TEMPERATURE: 68°

EQUIPMENT DATA

SEARCH UNIT
MANUFACTURER: KB.A
STYLE: MSWQC
FREQUENCY: 2.25MHz SIZE: 0.5"
SERIAL NO.: 44261
ANGLE: NOMINAL 45° MEASURED 43.7°
BEAM MODE: SHEAR

INSTRUMENT
MANUFACTURER: DANAMETRICS
MODEL: EPOCH IIB
SERIAL NO.: 91042006
CABLE: LENGTH 12' TYPE RG-174
COUPLANT/ BATCH #: ULTRAGEL II 093011

CALIBRATION DATA DAC



CALIBRATION TIMES

INITIAL: 0715 TECH.: JWD
CHECK: 0830 TECH.: JWD
CHECK: 1130 TECH.: JWD
FINAL: 1630 TECH.: JWD

VERIFICATION

AMP	SWEEP	TECH.
58%	1.6	JWD

BLOCK: LMT.036

PULSE REPETITION RATE
ACCEPTABLE: YES

SCREEN SIZE 6.27"

Reference Data						
REFLECTOR:	3/4T	3/4T	1/4T	1/4T		
NODE/BACK RF:	3/8	5/8	7/8	1 1/8		
SWEEP/DEPTH Initial:	2.2	3.6	5.2	6.5	N	
SWEEP/DEPTH Final:	2.2	3.6	5.2	6.5		A
AMPLITUDE Initial:	80%	45%	20%	16%		
AMPLITUDE Final:	80%	45%	20%	16%		
SURFACE DIST:	0.974	1.647	2.251	2.915		

CONTROL SETTINGS

	INITIAL	FINAL
Reference Gain:	42.0dB	42.0dB
Sweep/Range:	0.627 IN/DIV	0.627 IN/DIV
Sweep/Delay:	0.000	0.000
Zero/Offset:	5.862	5.862
Frequency:	2.25MHz	2.25MHz
Velocity:	0.1219	0.1219
Damping:	400 ohms	400 ohms
Reject:	0%	0%
Filter:	ON	ON
Energy:	HIGH	HIGH

COMPONENTS EXAMINED

WELD #	02AD-F8	02AD-F9	02AD-F12	02AD-S5	02AD-S6	02AB-S10A
SHEET #	R-056	R-057	R-058	R-059	R-060	R-061

EXAMINER: J.L. Devers LEVEL: II DATE: 03.05.96
REVIEWER: T.L. Blechinger LEVEL: II DATE: 3 6 96
OTHER: LEVEL:
STATION: DATE: ANII:

STATION/UNIT [illegible] DATA SHEET NO. C-027 PAGE 2 OF 2

EXAMINED/LEVEL J.L. DEVERS / II DATE 03-05-96

REVIEWER/LEVEL T.C. BLECHINGER / II DATE 3-6-96

ULTRASONIC CALIBRATION FORM NDT-LF-2 CONTINUATION

COMPONENTS EXAMINED

WELD # 02BD-S5

SHEET # R-062

ULTRASONIC TESTING DATA SHEET NDT-DS-C2A

STATION/UNIT: Quad Cities, 1, Q1R14 PAGE: 1 OF 5

PROCEDURE: NDT- C-2 REV. 22 DATA SHEET NO.: R-058 DATE: 03-05-96

CALIBRATION SHEET NO.(S)

ST. BEAM: N/A ANGLE BEAM: axial C-027 circ. C-027

COMPONENT INSPECTED

SYSTEM: RECIRC WELD #: 02AD-F12 WELD TYPE: PUMP TO PIPE

PIPE SIZE: 28" THICKNESS/SCHEDULE: 1.361" MATERIAL: S/S

COMPONENT TEMPERATURE: 76°

SCAN GAIN CONTROL SETTINGS

STRAIGHT BEAM: N/A ANGLE BEAM AXIAL: 54.0 dB

COUPLANT/ BATCH #: ULTRAGEL II 093011 ANGLE BEAM CIRC.: 54.0 dB

EXAMINATION SCANS

PIPE ↑ FLOW Pump

	Performed YES	Performed NO	Indications NO	Indications YES
1) Base Metal Straight Beam		✓		
2) Angle Beam-Normal-Against Flow	✓			LINEAR INDICATIONS SEE ATTACHED
3) Angle Beam-Normal-With Flow		✓		
4) Angle Beam-Along Weld-CW	✓		✓	
5) Angle Beam-Along Weld-CCW	✓		✓	
6) Straight Beam of Weld		✓		
7) Thickness Across Weld & Base Metal		✓	SEE ATTACHED	

UP STRM	WELD	DN STR
		T & C

ADDITIONAL COMMENTS

NO SCAN 3 DUE TO PUMP TO PIPE CONFIGURATION.

SCANS 4 & 5 LIMITED TO WELD & DOWNSTREAM BASE METAL ONLY.

SCANS 4 & 5 ALSO INCLUDED SEPERATE SKEW SCANS.

EXAMINATION ALSO INCLUDED REVIEW OF PREVIOUS EXAMINATION RESULTS.

EXAMINER: J.L. Devers LEVEL: II DATE: 03-05-96

REVIEWER: T.P. Brechinger LEVEL: II DATE: 3-6-96

OTHER: LEVEL: DATE:

STATION: DATE:

ANII: DATE:

Ultrasonic Data Sheet NDT-DS-C2B

PAGE 2 OF 5

Examiner: J.L. DEVERS Level: II Date: 03.05.96 Procedure Used: NDT-C-2, REV. 22

Data Sheet No.: R-058 Calibration Sheet No.: C-027 Component No.: 02AD-F12

Reference Point Locations: ℄ of WELD, V-STAMP (T.D.C.)

			Sweep Distance			Linear Extent From Reference			Fore and Aft Surface Distance			
Exam No.	Ind. No.	Max Amp	50%-20% Toward	At Max	50%-20% Away	Start	At Max	End	50%-20% Toward	At Max	50%-20% Away	Evaluation / Comments
2	1	100% DAC	2.9 DIA / 1.86 MP	3.0 DIA / 1.88 MP	3.4 DIA / 2.130 MP	1.75" CCW	2.40" CCW	3.80" CCW	1.20"	1.40"	1.60"	LINEAR INDICATION (I.G.S.C.C.)
2	2	100% DAC	2.8 DIA / 1.755 MP	2.0 DIA / 1.881 MP	2.3 DIA / 2.006 MP	13.50" CCW	14.75" CCW	16.00" CCW	1.20"	1.40"	1.70"	LINEAR INDICATION (I.G.S.C.C.)

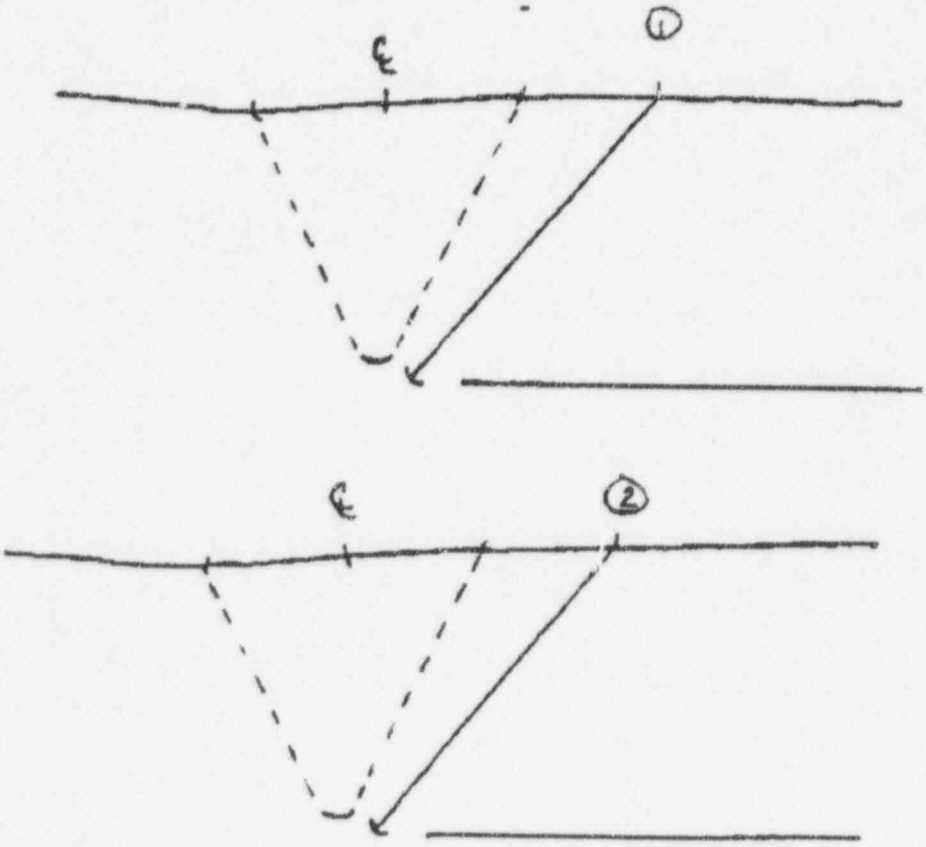
EXAMINER: J.L. DEVERS Level: II Date: 03.05.96
LMT
REVIEWER: T.P. BLECHINGER Level: II Date: 3-6-96
OTHER: Level: Date:
STATION: Date: ANII: Date:

STATION/UNIT Quad Cities 1 DATA SHEET NO. R-058 PAGE 3 OF 5

EXAMINER/LEVEL J.C. Peters L/II DATE 03-05-96

REVIEWER/LEVEL T.P. Blackinger / L III DATE 3-6-96

WELD NO. 02AD-F12



① INDICATION #1 @ 2.40" CCW FROM V-STAMP (T.D.C.)

② INDICATION #2 @ 14.75" CCW FROM V-STAMP (T.D.C.)

STATION/UNIT Q1R14 DATA SHEET NO. R-058 PAGE 4 OF 5

EXAMINER/LEVEL J.L. Powers / II DATE 3-5-96

REVIEWER/LEVEL T.R. Berchinger / II DATE 3-6-96

THICKNESS/PROFILE REPORT PRODUCED FROM PREVIOUS DATA SHEET

GENERAL ELECTRIC

WALL THICKNESS PROFILE SHEET

SHEET NO. R-084

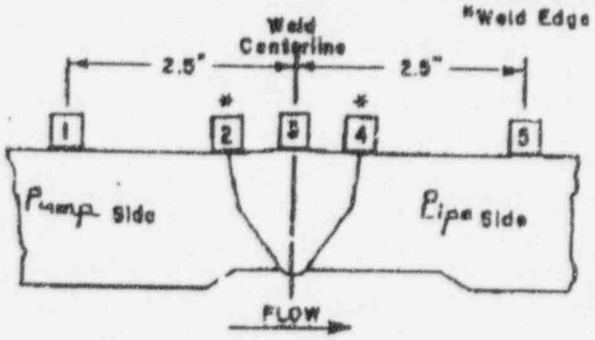
PROJECT: Quad Cities Unit 1

SYSTEM RECIRC WELD NO Q2AD-F12

UT Examination Data Sheet No. R-084

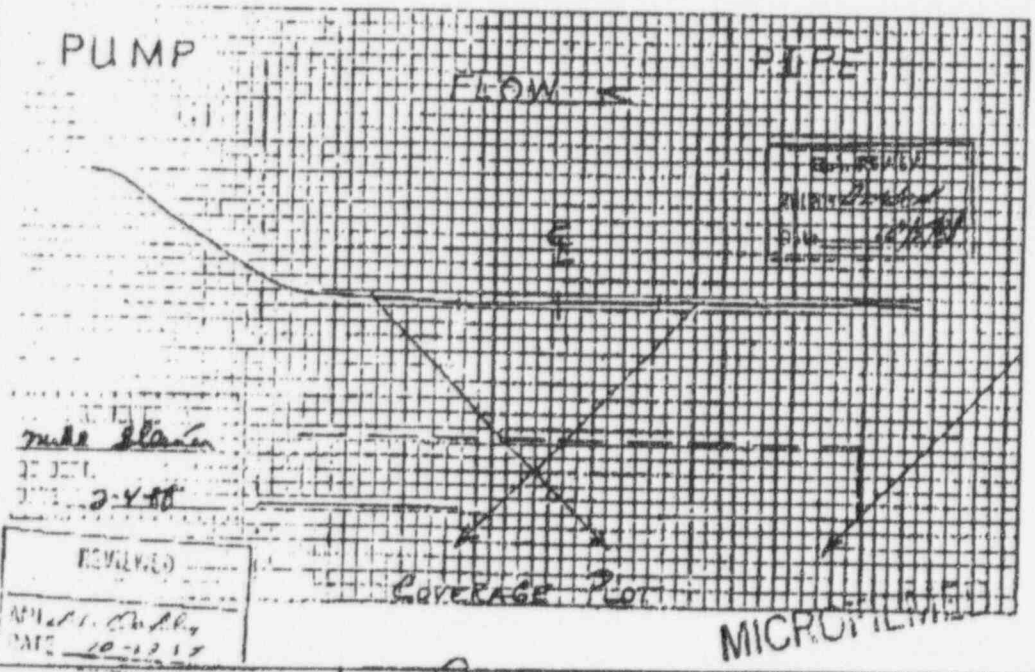
Record Thickness Measurement As Indicate. Including Weld Width. Edge-To-Edge At 0.°

Position	0°	90°	180°	270°
1	N/A			
2	1.40"			
3	1.35"			
4	1.45"			
5	1.45"			



CROWN HEIGHT: .05" DIAMETER: 28"

CROWN WIDTH: 1.4" WELD LENGTH: 90.5"



MICROFILMED

EXAMINED BY Wade Helenk II DATE 10-13-87

REVIEWED BY [illegible] DATE 10-27-87

REVIEWED BY T. Thomas Hooker DATE 10/21/87

PAGE 4 OF 4

Attachment A

NED-P-MSD-088

Revision 0

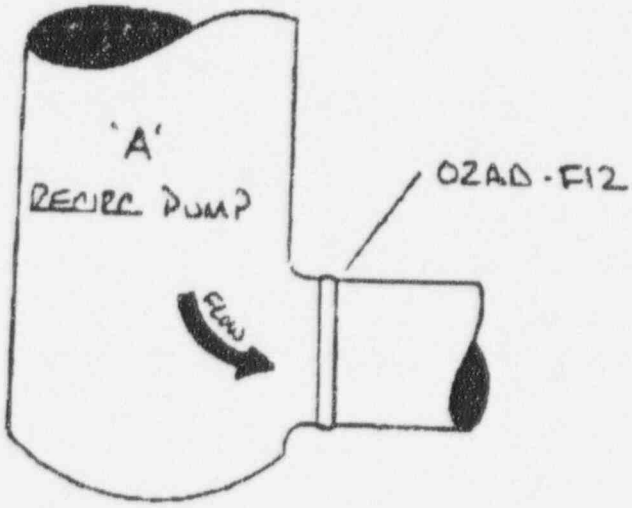
A8

STATION/UNIT QUAD CITIES / DATA SHEET NO. R-058 PAGE 5 OF 5

EXAMINER/LEVEL J. [illegible] / 4D DATE 03-05-96

REVIEWER/LEVEL LMT P. BLECHINGER / II DATE 3-6-96

LIMITATION SHEET : WELD # 02AD-F12



NO SCAN 3 DUE TO PUMP TO PIPE CONFIGURATION.
SCANS 4 & 5 LIMITED TO WELD & DOWNSTREAM BASE METAL ONLY.

ULTRASONIC CALIBRATION FORM NDT-CF-C1
(FIGURE 4)

Station/Unit: QUAD CITIES	Page: 1 of 1
Linearity Calibration sheet No.: L-020	Linearity Date: 3/6/96

CALIBRATION BLOCK

Linearity Calibration Block Number: LMT-037

ULTRASONIC INSTRUMENT DATA

Manufacturer: STAVELY	Model: SONIC 136
S/N: 3996	Cal. Due: 5/3/96

SCREEN HEIGHT LINEARITY

Continuous Gain Control

High %	100	90	80	70	60	50	40	30	20
Low%	50	45	40	35	30	25	20	15	10

Two Decibel Step Gain

dB	+ 2	00	- 2	- 4	- 6	- 8	- 10	- 12	- 14
High%	N/A	80				N/A			
Low%		40							

AMPLITUDE CONTROL LINEARITY

Amplitude %	80%	80%	40%	20%
dB Change	- 6 3/7/96	- 12	+ 6	+ 12
Reading %	~~40~~ 41	22	78	78
Limits %	32 - 48	16 - 24	64 - 96	64 - 96

Instrument Performance	Accept: ✓	Reject: N/A
Examiner: WAYNE L THOMAS	Level: II	Date: 3/6/96
LMT Reviewer: JM Johnson	Level: II	Date: 3-7-96
Other:	Level:	Date:
Station:		Date:
ANII:		Date:

ULTRASONIC SIZING CALIBRATION AND DATA SHEET NDT-CF-C3

DATA SHT. # R-063 SH. 1 of _

Station: QUAD CITIES Unit: 1 Date: 3/6/96

Examiner: WAYNE L. THOMAS Level: II Couplant/Lot: ULTRAGEL II 093011

System: RR Component No.: 02AD-F12

Calibration Std. No.: 99975 QC / NOTCH SET 2 Calibration Std. Temp.: 60

Linearity Sheet No.: L-020 Cal. Times: Initial: 0930 Final: 1735

Procedure No.: NDT-C-41 Rev.: 2 Technique: SPOT

Ultrasonic Scope:

Manufacture: KBA
Model: ALPHA
Serial No.: 399G
Cable: Type: RG-174
Length: 12'

Transducer:

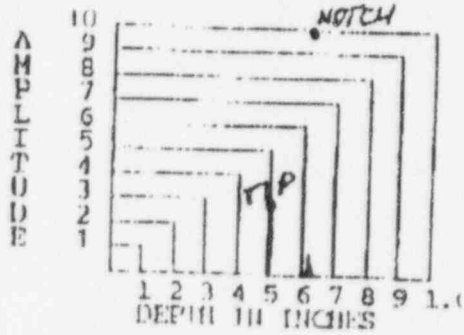
Manuf.: KBA
Freq.: 5.0
Size: .50" Ø
S/N: A18474
Focus Depth: N/A

Angle: 60°
Wave Mode: SHEAR
Wedge: 60175
Metal Path: N/A

Instrument Controls:

Range: 4.44"
Delay: 2.51
Reject: OFF
Damping: 200Ω
Ref. Gain: 74.4

Filter: 2.25
Velocity: .118
Zero Offset: N/A
Energy: N/A
Pulser: 222ns



Technique: SHOT: N/A PATT: N/A MOST: N/A OTHER: SPOT

Indication Number	L (In.) from Zero Ref.	Total Length	Thru-Wall Dimension	Side of Weld	Type of Reflector
1	2.25		.14	PIPE	LINEAR
2	15°		.16	PIPE	LINEAR
			N		
			A		

Reviewed by:

Examiner: WAYNE L. THOMAS Level: II Date: 3/6/96

LMT Reviewer: R.L. MAY Level: III Date: 3-7-96

Other: _____ Level: ___ Date:

Station: _____

Unit: _____

Attachment A
NED-P-MSD-088
Revision 0
A11

ULTRASONIC SIZING CALIBRATION AND DATA SHEET NDT-CF-C3

DATA SHT. # R063 Sh. 2 of

Station: QUAD CITIES Unit: 1 Date: 3/6/96

Examiner: W.L. THOMAS Level: II Couplant/Lot: ULTRAGEL II 093011

System: RR Component No.: Q2AD-F12

Calibration Std. No.: 99975 QC / NOTCH SET 2 Calibration Std. Temp.: 60°F

Linearity Sheet No.: L-020 Cal. Times: Initial: 1245 Final: 1724

Procedure No.: NDT-C-41 Rev.: 2 Technique: HIGH ANGLE L

Ultrasonic Scope:

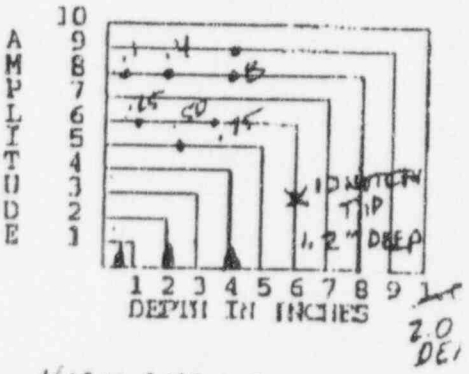
Manufacture: STAVELY
Model: SONIC 136
Serial No.: 399G
Cable: Type: RG-174
Length: 6' DUAL

Transducer:

Manuf.: MEGASONICS Angle: 60°
Freq.: 2.25 Wave Mode: LONG
Size: .38 x .75 Wedge: N/A
S/N: 91258 Metal Path: N/A
Focus Depth: .800"

Instrument Controls:

Range: 3.57" Filter: 2.25
Delay: 1.28 Velocity: .233
Reject: OFF Zero Offset: N/A
Damping: 200Ω Energy: N/A
Ref. Gain: 59.4 Pulser: 222 ns



Technique: SKIP: N/A PATT: N/A MOST: N/A OTHER: HIGH ANGLE L

Indication Number	L (in.) from Zero Ref.	Total Length	Thru-Wall Dimension	Side of Weld	Type of Reflector
1	2.25"	2.05"	<10%	D.S.	LINEAR
2	15"	2.50"	.18	D.S.	LINEAR
			N		
			A		

Reviewed by:

Examiner: W.L. THOMAS Level: II Date: 3/6/96

Reviewer: R.L. MAY (LMT) Level: III Date: 3-7-96

Other: Level: Date:

Station:

ANII:

COMED NUCLEAR DESIGN INFORMATION TRANSMITTAL

[X] SAFETY-RELATED
[ ] NON-SAFETY-RELATED
[ ] REGULATORY RELATED

Originating Organization
[ ] ComEd
[X] Other (specify) Sargent & Lundy

NDIT No. S040-OH-0262-00

Station Quad Cities Unit(s) 1
Design Change Authority No.:
System Designation: RR

Page 1 of 1

To G. H. DeBoo - ComEd

Subject Transmittal of Forces and Moments at NP 81 on Reactor Recirculation Piping due to a Cracked Weld

L. Kaushansky (Preparer)	Project Engineer (Position)	L Kaushansky (Preparer's Signature)	3-8-96 (Date)
A. I. Gershman (Reviewer)	Project Engineer (Position)	A I Gershman (Reviewer's Signature)	3-8-96 (Date)

Status of Information: [X] Approved for Use [ ] Unverified [ ] Engineering Judgement

Method and Schedule of Verification for Unverified NDITs:

Description of Information:

Reference: ABB Reactor Recirculation Piping Report Q1-RRCI-01C, Rev 14, transferred to S&L on 06-09-93, filed under EMD-067693, Rev. 00

Per your request, this NDIT transmits the forces and moments on the Recirc. Pump 1A-202 discharge nozzle from the above reference.

N.P. 81 (loads in LBS, moments in FT-LBS)

Local Coordinates Used (F_a= Axial Force, F_b= Vertical Force, M_a= Torsional Moment, M_b= Vertical Moment)

	F_a	F_b	F_c	M_a	M_b	M_c
WT	-1866	1218	332	-23977	-2629	-27683
TH 1	2032	4548	3089	-40111	34566	-31989
TH 2	2046	4585	3077	-40654	34995	-32166
TH 3	1204	2552	1768	-22529	19721	-18872
OBE	1695	2110	1729	5213	6688	16324

TH 1 is Normal Operation w/RWCU in service; TH 2 is Normal Operation w/o RWCU in service; TH 3 is Shutdown of RR line w/RWCU; OBE is the maximum of (X+Y) or (Z+Y)

Purpose of Issuance:
To transmit forces and moments at NP 81 on the RR Piping

Source of Information:
See above reference

Distribution:
NEDCC CHRON - DG
R. C. Lindberg - QUA
A. I. Gershman - 23
D. Bianchini - 23

Attachment B
NED-P-MSD-088
Revision 0
B1 Final

Project No. 10004-001 File No.: N/A CHRON No.: N/A

tm
pc-CRACK
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SAN JOSE, CA (408)978-8200
VERSION 2.1

Date: 1-Mar-1996
Time: 11:53:17.83

LEAST SQUARE CURVE FIT OF STRESS PROFILE

02BS-S12 RESIDUAL

TERM	COEFFICIENT
C0	3.045E+01
C1	-1.780E+02
C2	2.154E+02
C3	-6.963E+01

COEFFICIENT OF DETERMINATION R^2= 0.9991
CORRELATION COEFFICIENT= 0.9983

X VALUE	Y VALUE	Y CALC	DIFF
0.000E+00	3.000E+01	3.045E+01	-4.531E-01
1.250E-01	1.190E+01	1.143E+01	4.706E-01
2.500E-01	-1.250E+00	-1.678E+00	4.277E-01
3.750E-01	-9.620E+00	-9.684E+00	6.425E-02
5.000E-01	-1.370E+01	-1.341E+01	-2.937E-01
6.250E-01	-1.410E+01	-1.366E+01	-4.401E-01
7.500E-01	-1.155E+01	-1.126E+01	-2.891E-01
8.750E-01	-6.950E+00	-7.025E+00	7.540E-02
1.000E+00	-1.330E+00	-1.769E+00	4.394E-01
1.125E+00	4.130E+00	3.691E+00	4.389E-01
1.250E+00	8.100E+00	8.540E+00	-4.401E-01

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SAN JOSE, CA (408)978-8200
VERSION 2.1

Date: 10-Mar-1996
Time: 10:49:31.66

LINEAR ELASTIC FRACTURE MECHANICS EVALUATION

WELD 02AD-F12 KI VS DELTA A

crack model:CIRCUMFERENTIAL CRACK IN CYLINDER (T/R=0.1)

WALL THICKNESS (t)= 1.3590

STRESS COEFFICIENTS

CASE ID	C0	C1	C2	C3
RESIDUAL	30.4531	-178.0312	215.4409	-69.6322
TH-TRANS	-7.9000	13.1670	0.0000	0.0000
PRES,WT,TH	7.4000	0.0000	0.0000	0.0000

CRACK SIZE	STRESS INTENSITY FACTOR CASE RESIDUAL	CASE TH-TRANS	CASE PRES,WT,TH
0.0190	7.721	-2.100	2.004
0.0380	10.242	-2.925	2.846
0.0570	11.740	-3.528	3.499
0.0760	12.658	-4.009	4.056
0.0950	13.179	-4.410	4.552
0.1140	13.406	-4.751	5.006
0.1330	13.404	-5.044	5.428
0.1520	13.294	-5.328	5.856
0.1710	13.042	-5.586	6.275
0.1900	12.659	-5.817	6.681
0.2090	12.163	-6.025	7.077
0.2280	11.569	-6.210	7.464
0.2470	10.889	-6.374	7.845
0.2660	10.135	-6.520	8.220
0.2850	9.364	-6.671	8.618
0.3040	8.552	-6.816	9.028
0.3230	7.686	-6.946	9.436
0.3420	6.773	-7.060	9.843
0.3610	5.817	-7.159	10.251
0.3800	4.825	-7.243	10.658
0.3990	3.801	-7.313	11.066
0.4180	2.880	-7.411	11.522
0.4370	2.051	-7.531	12.021

0.4560	1.209	-7.640	12.524
0.4750	0.360	-7.736	13.033
0.4940	-0.493	-7.819	13.546
0.5130	-1.346	-7.890	14.064
0.5320	-2.196	-7.948	14.587
0.5510	-3.039	-8.001	15.126
0.5700	-3.880	-8.054	15.687
0.5890	-4.715	-8.094	16.254
0.6080	-5.542	-8.121	16.827
0.6270	-6.359	-8.134	17.406
0.6460	-7.162	-8.133	17.990
0.6650	-7.950	-8.118	18.579
0.6840	-8.750	-8.092	19.186
0.7030	-9.636	-8.061	19.835
0.7220	-10.513	-8.013	20.491
0.7410	-11.380	-7.949	21.153
0.7600	-12.234	-7.867	21.822
0.7790	-13.074	-7.768	22.498
0.7980	-13.897	-7.652	23.180
0.8170	-14.656	-7.523	23.873
0.8360	-14.864	-7.443	24.621
0.8550	-15.017	-7.346	25.376
0.8740	-15.114	-7.234	26.[illegible]
0.8930	-15.152	-7.104	26.909
0.9120	-15.129	-6.957	27.686
0.9310	-15.045	-6.793	28.471
0.9500	-14.897	-6.612	29.263

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VERSION 2.1

Date: 10-Mar-1996
Time: 11: 4:18.99

STRESS CORROSION CRACK GROWTH ANALYSIS

WELD 02AD-F12 IGSCC FOR A=0.180"

INITIAL CRACK SIZE= 0.1800
WALL THICKNESS= 1.3590
MAX CRACK SIZE FOR SCCG= 0.9500

STRESS CORROSION CRACK GROWTH LAW

LAW ID	C	N	Kthres	K1C
NRC IGSCC	3.590E-08	2.1610	0.0000	200.0000

STRESS COEFFICIENTS

CASE ID	C0	C1	C2	C3
RESIDUAL	30.4531	-178.0312	215.4409	-69.6322
TH-TRANS	-7.9000	13.1670	0.0000	0.0000
PRES,WT,TH	7.4000	0.0000	0.0000	0.0000

Kmax CASE ID	SCALE FACTOR
RESIDUAL	1.0000
PRES,WT,TH	1.0000

TIME	TIME INCREMENT	PRINT INCREMENT
44000.0	1000.0	1000.0

crack model:CIRCUMFERENTIAL CRACK IN CYLINDER (T/R=0.1)

CRACK SIZE	STRESS INTENSITY FACTOR CASE RESIDUAL	CASE TH-TRANS	CASE PRES,WT,TH
0.0190	7.721	-2.100	2.004
0.0380	10.242	-2.925	2.846
0.0570	11.740	-3.528	3.499
0.0760	12.658	-4.009	4.056
0.0950	13.179	-4.410	4.552
0.1140	13.406	-4.751	5.006
0.1330	13.404	-5.044	5.428

0.1520	13.294	-5.328	5.856
0.1710	13.042	-5.586	6.275
0.1900	12.659	-5.817	6.681
0.2090	12.163	-6.025	7.077
0.2280	11.569	-6.210	7.464
0.2470	10.889	-6.374	7.845
0.2660	10.135	-6.520	8.220
0.2850	9.364	-6.671	8.618
0.3040	8.552	-6.816	9.028
0.3230	7.686	-6.946	9.436
0.3420	6.773	-7.060	9.843
0.3610	5.817	-7.159	10.251
0.3800	4.825	-7.243	10.658
0.3990	3.801	-7.313	11.066
0.4180	2.880	-7.411	11.522
0.4370	2.051	-7.531	12.021
0.4560	1.209	-7.640	12.524
0.4750	0.360	-7.736	13.033
0.4940	-0.493	-7.819	13.546
0.5130	-1.346	-7.890	14.064
0.5320	-2.196	-7.948	14.587
0.5510	-3.039	-8.001	15.126
0.5700	-3.880	-8.054	15.687
0.5890	-4.715	-8.094	16.254
0.6080	-5.542	-8.121	16.827
0.6270	-6.359	-8.134	17.406
0.6460	-7.162	-8.133	17.990
0.6650	-7.950	-8.118	18.579
0.6840	-8.750	-8.092	19.186
0.7030	-9.636	-8.061	19.835
0.7220	-10.513	-8.013	20.491
0.7410	-11.380	-7.949	21.153
0.7600	-12.234	-7.867	21.822
0.7790	-13.074	-7.768	22.498
0.7980	-13.897	-7.652	23.180
0.8170	-14.656	-7.523	23.873
0.8360	-14.864	-7.443	24.621
0.8550	-15.017	-7.346	25.376
0.8740	-15.114	-7.234	26.139
0.8930	-15.152	-7.104	26.909
0.9120	-15.129	-6.957	27.686
0.9310	-15.045	-6.793	28.471
0.9500	-14.897	-6.612	29.263

TIME	KMAX	DA/DT	DA	A	A/THK
1000.0	19.33	2.160E-05	0.0216	0.2016	0.148
2000.0	19.28	2.149E-05	0.0215	0.2231	0.164
3000.0	19.09	2.103E-05	0.0210	0.2441	0.180
4000.0	18.78	2.030E-05	0.0203	0.2644	0.195

5000.0	18.39	1.940E-05	0.0194	0.2838	0.209
6000.0	18.01	1.854E-05	0.0185	0.3023	0.222
7000.0	17.61	1.768E-05	0.0177	0.3200	0.235
8000.0	17.19	1.678E-05	0.0168	0.3368	0.248
9000.0	16.75	1.586E-05	0.0159	0.3527	0.260
10000.0	16.31	1.497E-05	0.0150	0.3676	0.271
11000.0	15.86	1.410E-05	0.0141	0.3817	0.281
12000.0	15.43	1.327E-05	0.0133	0.3950	0.291
13000.0	15.00	1.249E-05	0.0125	0.4075	0.300
14000.0	14.66	1.189E-05	0.0119	0.4194	0.309
15000.0	14.38	1.140E-05	0.0114	0.4308	0.317
16000.0	14.18	1.106E-05	0.0111	0.4418	0.325
17000.0	13.99	1.074E-05	0.0107	0.4526	0.333
18000.0	13.79	1.042E-05	0.0104	0.4630	0.341
19000.0	13.61	1.012E-05	0.0101	0.4731	0.348
20000.0	13.43	9.832E-06	0.0098	0.4830	0.355
21000.0	13.25	9.555E-06	0.0096	0.4925	0.362
22000.0	13.08	9.291E-06	0.0093	0.5018	0.369
23000.0	12.92	9.041E-06	0.0090	0.5108	0.376
24000.0	12.76	8.801E-06	0.0088	0.5196	0.382
25000.0	12.60	8.576E-06	0.0086	0.5282	0.389
26000.0	12.46	8.361E-06	0.0084	0.5366	0.395
27000.0	12.32	8.161E-06	0.0082	0.5447	0.401
28000.0	12.19	7.975E-06	0.0080	0.5527	0.407
29000.0	12.06	7.799E-06	0.0078	0.5605	0.412
30000.0	11.95	7.639E-06	0.0076	0.5682	0.418
31000.0	11.83	7.485E-06	0.0075	0.5756	0.424
32000.0	11.73	7.340E-06	0.0073	0.5830	0.429
33000.0	11.62	7.201E-06	0.0072	0.5902	0.434
34000.0	11.52	7.067E-06	0.0071	0.5972	0.439
35000.0	11.43	6.942E-06	0.0069	0.6042	0.445
36000.0	11.34	6.820E-06	0.0068	0.6110	0.450
37000.0	11.25	6.705E-06	0.0067	0.6177	0.455
38000.0	11.16	6.598E-06	0.0066	0.6243	0.459
39000.0	11.08	6.492E-06	0.0065	0.6308	0.464
40000.0	11.00	6.395E-06	0.0064	0.6372	0.469
41000.0	10.93	6.302E-06	0.0063	0.6435	0.474
42000.0	10.86	6.212E-06	0.0062	0.6497	0.478
43000.0	10.79	6.129E-06	0.0061	0.6558	0.483
44000.0	10.73	6.050E-06	0.0061	0.6619	0.487

tm
pc-CRACK

VERSION 2.1

Date: 10-Mar-1996
Time: 11: 9:59.74

STRESS CORROSION CRACK GROWTH ANALYSIS

WELD 02AD-F12 IGSCC FOR A=0.140"

INITIAL CRACK SIZE= 0.1400
WALL THICKNESS= 1.3590
MAX CRACK SIZE FOR SCCG= 0.9500

STRESS CORROSION CRACK GROWTH LAW

LAW ID	C	N	Kthres	K1C
NRC IGSCC	3.590E-08	2.1610	0.0000	200.0000

STRESS COEFFICIENTS

CASE ID	C0	C1	C2	C3
RESIDUAL	30.4531	-178.0312	215.4409	-69.6322
TH-TRANS	-7.9000	13.1670	0.0000	0.0000
PRES,WT,TH	7.4000	0.0000	0.0000	0.0000

Kmax CASE ID	SCALE FACTOR
RESIDUAL	1.0000
PRES,WT,TH	1.0000

TIME	TIME INCREMENT	PRINT INCREMENT
44000.0	1000.0	1000.0

crack model:CIRCUMFERENTIAL CRACK IN CYLINDER (T/R=0.1)

CRACK SIZE	STRESS INTENSITY FACTOR CASE RESIDUAL	CASE TH-TRANS	CASE PRES,WT,TH
0.0190	7.721	-2.100	2.004
0.0380	10.242	-2.925	2.846
0.0570	11.740	-3.528	3.499
0.0760	12.658	-4.009	4.056
0.0950	13.179	-4.410	4.552
0.1140	13.406	-4.751	5.006
0.1330	13.404	-5.044	5.428

0.1520	13.294	-5.328	5.856
0.1710	13.042	-5.586	6.275
0.1900	12.659	-5.817	6.681
0.2090	12.163	-6.025	7.077
0.2280	11.569	-6.210	7.464
0.2470	10.889	-6.374	7.845
0.2660	10.135	-6.520	8.220
0.2850	9.364	-6.671	8.618
0.3040	8.552	-6.816	9.028
0.3230	7.686	-6.946	9.436
0.3420	6.773	-7.060	9.843
0.3610	5.817	-7.159	10.251
0.3800	4.825	-7.243	10.658
0.3990	3.801	-7.313	11.066
0.4180	2.880	-7.411	11.522
0.4370	2.051	-7.531	12.021
0.4560	1.209	-7.640	12.524
0.4750	0.360	-7.736	13.033
0.4940	-0.493	-7.819	13.546
0.5130	-1.346	-7.890	14.064
0.5320	-2.196	-7.948	14.587
0.5510	-3.039	-8.001	15.126
0.5700	-3.880	-8.054	15.687
0.5890	-4.715	-8.094	16.254
0.6080	-5.542	-8.121	16.827
0.6270	-6.359	-8.134	17.406
0.6460	-7.162	-8.133	17.990
0.6650	-7.950	-8.118	18.579
0.6840	-8.750	-8.092	19.186
0.7030	-9.636	-8.061	19.835
0.7220	-10.513	-8.013	20.491
0.7410	-11.380	-7.949	21.153
0.7600	-12.234	-7.867	21.822
0.7790	-13.074	-7.768	22.498
0.7980	-13.897	-7.652	23.180
0.8170	-14.656	-7.523	23.873
0.8360	-14.864	-7.443	24.621
0.8550	-15.017	-7.346	25.376
0.8740	-15.114	-7.234	26.139
0.8930	-15.152	-7.104	26.909
0.9120	-15.129	-6.957	27.686
0.9310	-15.045	-6.793	28.471
0.9500	-14.897	-6.612	29.263

TIME	KMAX	DA/DT	DA	A	A/THK
1000.0	18.95	2.070E-05	0.0207	0.1607	0.118
2000.0	19.23	2.136E-05	0.0214	0.1821	0.134
3000.0	19.33	2.161E-05	0.0216	0.2037	0.150
4000.0	19.27	2.146E-05	0.0215	0.2251	0.166

5000.0	19.06	2.097E-05	0.0210	0.2461	0.181
6000.0	18.75	2.023E-05	0.0202	0.2663	0.196
7000.0	18.35	1.931E-05	0.0193	0.2856	0.210
8000.0	17.97	1.845E-05	0.0185	0.3041	0.224
9000.0	17.58	1.760E-05	0.0176	0.3217	0.237
10000.0	17.15	1.669E-05	0.0167	0.3384	0.249
11000.0	16.71	1.578E-05	0.0158	0.3542	0.261
12000.0	16.26	1.488E-05	0.0149	0.3690	0.272
13000.0	15.82	1.402E-05	0.0140	0.3831	0.282
14000.0	15.38	1.319E-05	0.0132	0.3963	0.292
15000.0	14.96	1.241E-05	0.0124	0.4087	0.301
16000.0	14.63	1.184E-05	0.0118	0.4205	0.309
17000.0	14.36	1.137E-05	0.0114	0.4319	0.318
18000.0	14.16	1.103E-05	0.0110	0.4429	0.326
19000.0	13.97	1.071E-05	0.0107	0.4536	0.334
20000.0	13.78	1.039E-05	0.0104	0.4640	0.341
21000.0	13.59	1.009E-05	0.0101	0.4741	0.349
22000.0	13.41	9.804E-06	0.0098	0.4839	0.356
23000.0	13.23	9.529E-06	0.0095	0.4934	0.363
24000.0	13.06	9.266E-06	0.0093	0.5027	0.370
25000.0	12.90	9.017E-06	0.0090	0.5117	0.377
26000.0	12.74	8.779E-06	0.0088	0.5205	0.383
27000.0	12.59	8.555E-06	0.0086	0.5290	0.389
28000.0	12.44	8.340E-06	0.0083	0.5374	0.395
29000.0	12.31	8.143E-06	0.0081	0.5455	0.401
30000.0	12.17	7.957E-06	0.0080	0.5535	0.407
31000.0	12.05	7.783E-06	0.0078	0.5613	0.413
32000.0	11.94	7.624E-06	0.0076	0.5689	0.419
33000.0	11.82	7.470E-06	0.0075	0.5764	0.424
34000.0	11.72	7.326E-06	0.0073	0.5837	0.429
35000.0	11.61	7.187E-06	0.0072	0.5909	0.435
36000.0	11.51	7.054E-06	0.0071	0.5979	0.440
37000.0	11.42	6.930E-06	0.0069	0.6049	0.445
38000.0	11.33	6.809E-06	0.0068	0.6117	0.450
39000.0	11.24	6.695E-06	0.0067	0.6184	0.455
40000.0	11.16	6.587E-06	0.0066	0.6249	0.460
41000.0	11.07	6.482E-06	0.0065	0.6314	0.465
42000.0	11.00	6.385E-06	0.0064	0.6378	.469
43000.0	10.92	6.293E-06	0.0063	0.6441	0.474
44000.0	10.85	6.203E-06	0.0062	0.6503	0.479

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pc-CRACK

STRUCTURAL INTEGRITY ASSOCIATES, INC.
SAN JOSE, CA (408)978-8200
VERSION 2.1

Date: 10-Mar-1996
Time: 11:37:53.60

FATIGUE CRACK GROWTH ANALYSIS

WELD 02AD-F12 FATIGUE CRACK GROWTH FOR FINAL FLAW DEPTH A=0.665"

INITIAL CRACK SIZE= 0.6650
WALL THICKNESS= 1.3590
MAX CRACK SIZE FOR FCG= 0.9500
TEMPERATURE= 550.0

ASME SECTION XI: AUSTENITIC STEEL WITH AIR ENVIRONMENT

da/dN = C * 10^F * S * dK^3.3

where

S = 1.0 for R < 0
= 1.0 + 1.8 * R for 0 < R < 0.79
= -43.35 + 57.97 * R for 0.79 < R < 1
F = code specified function of temperature
dK = Kmax - Kmin
R = Kmin / Kmax

WHERE:
C * 10^F = 1.84033E-10
IS FOR THE CURRENTLY ASSUMED UNITS OF:
FORCE: kips LENGTH: inches TEMPERATURE: Fahrenheit

STRESS COEFFICIENTS

CASE ID	C0	C1	C2	C3
RESIDUAL	30.4531	-178.0312	215.4409	-69.6322
TH-TRANS	-7.9000	13.1670	0.0000	0.0000
PRES,WT,TH	7.4000	0.0000	0.0000	0.0000

NUMBER OF CYCLE BLOCKS= 5
PRINT INCREMENT OF CYCLE BLOCK= 1

SUBBLOCK	NUMBER OF CYCLES	CALCULATION INCREMENT	PRINT INCREMENT	FCG LAW ID
1	1	1	1	SECT XI AUSTENITIC/AIR
2	1	1	1	SECT XI AUSTENITIC/AIR

SUBBLOCK	Kmax CASE ID	SCALE FACTOR	Kmin CASE ID	SCALE FACTOR
1	RESIDUAL	1.0000	RESIDUAL	1.0000
	PRES,WT,TH	1.0000		
2	RESIDUAL	1.0000	RESIDUAL	1.0000
	PRES,WT,TH	1.0000	PRES,WT,TH	0.9700
			TH-TRANS	1.0000

crack model:CIRCUMFERENTIAL CRACK IN CYLINDER (T/R=0.1)

CRACK SIZE	STRESS INTENSITY FACTOR CASE RESIDUAL	CASE TH-TRANS	CASE PRES,WT,TH
0.0190	7.721	-2.100	2.004
0.0380	10.242	-2.925	2.846
0.0570	11.740	-3.528	3.499
0.0760	12.658	-4.009	4.056
0.0950	13.179	-4.410	4.552
0.1140	13.406	-4.751	5.006
0.1330	13.404	-5.044	5.428
0.1520	13.294	-5.328	5.856
0.1710	13.042	-5.586	6.275
0.1900	12.659	-5.817	6.681
0.2090	12.163	-6.025	7.077
0.2280	11.569	-6.210	7.464
0.2470	10.889	-6.374	7.845
0.2660	10.135	-6.520	8.220
0.2850	9.364	-6.671	8.618
0.3040	8.552	-6.816	9.028
0.3230	7.686	-6.946	9.436
0.3420	6.773	-7.060	9.843
0.3610	5.817	-7.159	10.251
0.3800	4.825	-7.243	10.658
0.3990	3.801	-7.313	11.066
0.4180	2.880	-7.411	11.522
0.4370	2.051	-7.531	12.021
0.4560	1.209	-7.640	12.524
0.4750	0.360	-7.736	13.033
0.4940	-0.493	-7.819	13.546
0.5130	-1.346	-7.890	14.064
0.5320	-2.196	-7.948	14.587
0.5510	-3.039	-8.001	15.126
0.5700	-3.880	-8.054	15.687
0.5890	-4.715	-8.094	16.254
0.6080	-5.542	-8.121	16.827
0.6270	-6.359	-8.134	17.406
0.6460	-7.162	-8.133	17.990
0.6650	-7.950	-8.118	18.579
0.6840	-8.750	-8.092	19.186
0.7030	-9.636	-8.061	19.835
0.7220	-10.513	-8.013	20.491
0.7410	-11.380	-7.949	21.153
0.7600	-12.234	-7.867	21.822

0.7790	-13.074	-7.768	22.498
0.7980	-13.897	-7.652	23.180
0.8170	-14.656	-7.523	23.873
0.8360	-14.864	-7.443	24.621
0.8550	-15.017	-7.346	25.376
0.8740	-15.114	-7.234	26.139
0.8930	-15.152	-7.104	26.909
0.9120	-15.129	-6.957	27.686
0.9310	-15.045	-6.793	28.471
0.9500	-14.897	-6.612	29.263

TOTAL CYCLE	SUBBLOCK CYCLE	KMAX	KMIN	DELTAK	R	DADN	DA	A	A/T
BLOCK 1									
1	1	10.63	-7.95	18.58	-0.75	2.8E-06	0.0000	0.6650	0.49
2	1	10.63	1.95	8.68	0.18	3.1E-07	0.0000	0.6650	0.49
BLOCK 2									
3	1	10.63	-7.95	18.58	-0.75	2.8E-06	0.0000	0.6650	0.49
4	1	10.63	1.95	8.68	0.18	3.1E-07	0.0000	0.6650	0.49
BLOCK 3									
5	1	10.63	-7.95	18.58	-0.75	2.8E-06	0.0000	0.6650	0.49
6	1	10.63	1.95	8.68	0.18	3.1E-07	0.0000	0.6650	0.49
BLOCK 4									
7	1	10.63	-7.95	18.58	-0.75	2.8E-06	0.0000	0.6650	0.49
8	1	10.63	1.95	8.68	0.18	3.1E-07	0.0000	0.6650	0.49
BLOCK 5									
9	1	10.63	-7.95	18.58	-0.75	2.8E-06	0.0000	0.6650	0.49
10	1	10.63	1.95	8.68	0.18	3.1E-07	0.0000	0.6650	0.49

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pc-CRACK

STRUCTURAL INTEGRITY ASSOCIATES, INC.
SAN JOSE, CA (408)978-8200
VERSION 2.1

Date: 10-Mar-1996
Time: 11:11:56.13

FATIGUE CRACK GROWTH ANALYSIS

WELD 02AD-F12 FATIGUE CRACK GROWTH FOR INITIAL FLAW DEPTH A=0.180"

INITIAL CRACK SIZE= 0.1800
WALL THICKNESS= 1.3590
MAX CRACK SIZE FOR FCG= 0.9500
TEMPERATURE= 550.0

ASME SECTION XI: AUSTENITIC STEEL WITH AIR ENVIRONMENT

da/dN = C * 10^F * S * dK^3.3

where

S = 1.0 for R < 0
= 1.0 + 1.8 * R for 0 < R < 0.79
= -43.35 + 57.97 * R for 0.79 < R < 1
F = code specified function of temperature
dK = Kmax - Kmin
R = Kmin / Kmax

WHERE:
C * 10^F = 1.84033E-10
IS FOR THE CURRENTLY ASSUMED UNITS OF:
FORCE: kips LENGTH: inches TEMPERATURE: Fahrenheit

STRESS COEFFICIENTS

CASE ID	C0	C1	C2	C3
RESIDUAL	30.4531	-178.0312	215.4409	-69.6322
TH-TRANS	-7.9000	13.1670	0.0000	0.0000
PRES,WT,TH	7.4000	0.0000	0.0000	0.0000

NUMBER OF CYCLE BLOCKS= 5
PRINT INCREMENT OF CYCLE BLOCK= 1

SUBBLOCK	NUMBER OF CYCLES	CALCULATION INCREMENT	PRINT INCREMENT	FCG LAW ID
1	1	1	1	SECT XI AUSTENITIC/AIR
2	1	1	1	SECT XI AUSTENITIC/AIR

SUBBLOCK	Kmax CASE ID	SCALE FACTOR	Kmin CASE ID	SCALE FACTOR
1	RESIDUAL	1.0000	RESIDUAL	1.0000
	PRES,WT,TH	1.0000		
2	RESIDUAL	1.0000	RESIDUAL	1.0000
	PRES,WT,TH	1.0000	PRES,WT,TH	0.9700
			TH-TRANS	1.0000

crack model:CIRCUMFERENTIAL CRACK IN CYLINDER (T/R=0.1)

CRACK SIZE	----------STRESS INTENSITY FACTOR---------- CASE RESIDUAL	CASE TH-TRANS	CASE PRES,WT,TH
0.0190	7.721	-2.100	2.004
0.0380	10.242	-2.925	2.846
0.0570	11.740	-3.528	3.499
0.0760	12.658	-4.009	4.056
0.0950	13.179	-4.410	4.552
0.1140	13.406	-4.751	5.006
0.1330	13.404	-5.044	5.428
0.1520	13.294	-5.328	5.856
0.1710	13.042	-5.586	6.275
0.1900	12.659	-5.817	6.681
0.2090	12.163	-6.025	7.077
0.2280	11.569	-6.210	7.464
0.2470	10.889	-6.374	7.845
0.2660	10.135	-6.520	8.220
0.2850	9.364	-6.671	8.618
0.3040	8.552	-6.816	9.028
0.3230	7.686	-6.946	9.436
0.3420	6.773	-7.060	9.843
0.3610	5.817	-7.159	10.251
0.3800	4.825	-7.243	10.658
0.3990	3.801	-7.313	11.066
0.4180	2.880	-7.411	11.522
0.4370	2.051	-7.531	12.021
0.4560	1.209	-7.640	12.524
0.4750	0.360	-7.736	13.033
0.4940	-0.493	-7.819	13.546
0.5130	-1.346	-7.890	14.064
0.5320	-2.196	-7.948	14.587
0.5510	-3.039	-8.001	15.126
0.5700	-3.880	-8.054	15.687
0.5890	-4.715	-8.094	16.254
0.6080	-5.542	-8.121	16.827
0.6270	-6.359	-8.134	17.406
0.6460	-7.162	-8.133	17.990
0.6650	-7.950	-8.118	18.579
0.6840	-8.750	-8.092	19.186
0.7030	-9.636	-8.061	19.835
0.7220	-10.513	-8.013	20.491
0.7410	-11.380	-7.949	21.153
0.7600	-12.234	-7.867	21.822

0.7790	-13.074	-7.768	22.498
0.7980	-13.897	-7.652	23.180
0.8170	-14.656	-7.523	23.873
0.8360	-14.864	-7.443	24.621
0.8550	-15.017	-7.346	25.376
0.8740	-15.114	-7.234	26.139
0.8930	-15.152	-7.104	26.909
0.9120	-15.129	-6.957	27.686
0.9310	-15.045	-6.793	28.471
0.9500	-14.897	-6.612	29.263

TOTAL CYCLE	SUBBLOCK CYCLE	KMAX	KMIN	DELTAK	R	DADN	DA	A	A/T
BLOCK 1									
1	1	19.33	12.86	6.47	0.67	1.9E-07	0.0000	0.1800	0.13
2	1	19.33	13.44	5.89	0.70	1.4E-07	0.0000	0.1800	0.13
BLOCK 2									
3	1	19.33	12.86	6.47	0.67	1.9E-07	0.0000	0.1800	0.13
4	1	19.33	13.44	5.89	0.70	1.4E-07	0.0000	0.1800	0.13
BLOCK 3									
5	1	19.33	12.86	6.47	0.67	1.9E-07	0.0000	0.1800	0.13
6	1	19.33	13.44	5.89	0.70	1.4E-07	0.0000	0.1800	0.13
BLOCK 4									
7	1	19.33	12.86	6.47	0.67	1.9E-07	0.0000	0.1800	0.13
8	1	19.33	13.44	5.89	0.70	1.4E-07	0.0000	0.1800	0.13
BLOCK 5									
9	1	19.33	12.86	6.47	0.67	1.9E-07	0.0000	0.1800	0.13
10	1	19.33	13.44	5.89	0.70	1.4E-07	0.0000	0.1800	0.13