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ATTACHMENT 1

Form 01077 (R3-94)

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER CNS 1&2

TITLE OF CALCULATION 90-05 Cal on RN 4" Stainless Steel Butt WELDS

CALCULATION NUMBER CNC 1206.00-02-0007

ORIGINALLY CONSISTING OF:

PAGES 1 THROUGH 2

TOTAL ATTACHMENTS 4 TOTAL MICROFICHE ATTACHMENTS 0

TOTAL VOLUMES 1 TYPE I CALCULATION/ANALYSIS ☐ Yes ☑ No

TYPE I REVIEW FREQUENCY type IV

THESE ENGINEERING CALCULATIONS COVER QA CONDITION 1 ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY EW McElroy / J7 Willis DATE 5/2/95

CHECKED BY [illegible signatures] DATE 5/2/95 / 5/2/95 - 5/2/95

APPROVED BY D. L. Ward DATE 5/2/95

ISSUED TO DOCUMENT MANAGEMENT D L Ward DATE 5/3/95

RECEIVED BY DOCUMENT MANAGEMENT ______ DATE ______

MICROFICHE ATTACHMENT LIST: ☐ Yes ☐ No SEE FORM 101.4

REV. NO.	CALCULATION PAGES (VOL) REVISED	DELETED	ADDED	ATTACHMENTS (VOL) REVISED	DELETED	ADDED	VOLUMES DELETED	ADDED	ORIG DATE	CHKD DATE	APPR DATE	ISSUE DATE / REC'D DATE

9505230259 950511
PDR ADOCK 05000413
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1.0 PROBLEM STATEMENT
This calculation evaluates a through wall pitting located on a 4" butt welds on the RN system piping. The piping, is ASME Class 3 piping. This evaluation is required by NRC Generic Letter 90-05 and is referenced in PIP 0-C95-0527.

2.0 QA Condition
Piping addressed by this calculation is QA condition 1 and is a QA condition 1 calculation.

3.0 DESIGN METHOD
This calculation evaluates using the rules imposed by NRC Generic Letter 90-05, NSD 203 and ASME Section III.

4.0 APPLICABLE CODES AND STANDARDS
(1) ASME Section III 1974 Edition with addenda through summer 1974. (CNS Plant Base Code)
(2) Guidance For Performing Temporary Non-Code Repair of ASME Code Class 1,2, and 3 Piping (NRC Generic Letter 90-05)
(3) Duke Power Co. Nuclear Station Directive: 203. Operability
(4) ASME Code Case N-463
(5) Tech Spec 3/4.4.10 Structural Integrity

5.0 DESIGN INPUTS
Not Applicable

6.0 PSAR, FSAR CRITERIA
FSAR Volume 3, Table 3.2.2-3 identifies piping as complying with ASME & ANSI Codes.

7.0 ASSUMPTIONS
None

8.0 INFORMATION SOURCES
(1) Flow diagram CN-1574
(2) Met Lab Report 1812
(3) PIP 0-C95-0527

9.0 EVALUATION

This calculation evaluates the through wall region identified as the heat affect zone, HAZ, near the weld area. The evaluation approach is the "through-wall flaw" per "NRC Generic Letter 90-05" Attachment 3, the calculation meets the requirement of "K" less than 135 $ksi(in)^{0.5}$. This calculation uses the worse case generic sizing of the flaw. This is consistent with the lower-bound fracture toughness property in ASME Code Case N-463. The worse case flaw size is 3/8", in the pipe wall, Met Lab Report 1812. The actual examination of the pin hole with a magnifying glass while still installed was less than a 0.15", with a weepage of less than 1 drop per minute. A walk down of the all RN stainless steel piping, ¾" to 8", was completed by a Spoc team attachment 2 is a list of the 4" weld numbers identified.

10.0 CONCLUSION

The pin hole leaks in the HAZ on 4" RN stainless steel butt welds are acceptable per NRC Generic Letter 90-05 using the "Through-Wall Flaw" approach. The leaking RN piping will be replaced or repaired per a repair plan. The repair plan will be initiated as soon as possible, but will not force the system availability. The RN butt welds are operable with these pin hole leaks.

Prepared By Ernie McElroy Date 5/02/95

Checked By TH Maulshi Date 5/2/95

The pinhole leaks in the stainless steel portions of the RN system piping pose no threats from either a flooding or pipe rupture perspective. The flooding scenarios at the station are based on worst case pipe ruptures of various systems. These leaks are bounded by breaks already postulated. These leaks are all located in the heat affected zone of the welds. These weld locations were reviewed as part of the moderate energy piping water spray study for their potential affect on safety related equipment. A crack was postulated at each weld location in all moderate energy piping greater than 1" in diameter. These leaks are therefore also bounded by studies already in place at the plant. The only portions of piping which are excluded are those equal to or less than 1" in diameter. Since these are all located in areas of larger piping already reviewed for water spray effects, these leaks are also acceptable.

ACTUAL LEAKING WELDS OR SIGNS OF LEAKAGE
4" PIPING
Attachment 2

WELD #s		PIPE DIA.			
0RN 187-2		4"			
0RN 187-22		4"			
0RN 187-43		4"			
0RN 187-44		4"			
0RN 187-5		4"			
0RN 187-7		4"			
0RN 189-15		4"			
0RN 189-16		4"			
0RN 189-7		4"			
0RN 191-14		4"			
0RN 191-4		4"			
0RN 196-18		4"			
0RN 196-23		4"			
0RN 200-3		4"			
0RN 222-2		4"			
0RN 223-3		4"			
0RN 224-15		4"			
0RN 224-2		4"			
0RN 224-6		4"			
0RN 226-15		4"			
0RN 227-10		4"			
0RN-224-12		4"			

EWM 5/2/95

Butt Weld Flaw Characterization

Two of the three 4" Butt welds were section for flaw characterization. The ID penetrations were 3/16" to 3/8" from the toe of the weld. Each leak was reported on the underside of the pipe. The corrosion in the butt weld is described as propagating through wall starting as a pin hole, enlarging to ~ ¼" axially and circumferentially, and necking down to a pin hole as it exits the pipe's OD. A conservative estimation of the flaw size is to use the maximum enlargement of the cavity in the pipe wall, due to the changing geometry. The worse considered flaw in the butt welds is the first described leak in the Met Lab 1812 report. It is a pin hole leak on the bottom of the pipe with two tubercle on either side of the leak, figure 1. This assumes a through wall leak under every tubercle. The two tubercles approximately 3" either side of the bottom are far enough apart to consider them as three different leaks. There was no evidence of linking (cracking) between the pin holes. The two tubercles did have pitting occuring under them. One size, 3/8", per pin hole was used for butt welds and socket welds. This is the maximum cavity seen in the stainless steel RN piping. This is considered the worse case of all the observed leaking welds.
Case 1: 4" piping with one 3/8" hole, with reduced section modulus of the holes 3" apart.
This is analyzed in case 1, attachment 3 on 4" piping and is acceptable. The maximum weepage from any of the pin holes is less than 1 drop per minute. Using this as the maximum leaking flaw found in SS Butt welds in the RN system, and the maximum stresses applied, this passes generic letter 90-05, using the through wall flaw approach. The third butt 4" weld was left intact for NDE use.

90-05 Evaluation of Flawed Butt Welds

(Attachment 3)

Statement of Problem/Purpose

The purpose of this calculation is to evaluate the structural integrity of the thru-wall leaking flaws that exist in the stainless steel butt welds as listed in Table 3 (see sheet 4). The flaws were characterized in attachment 2A of this calculation. The characterized flaws will be covered by one case.

Quality Assurance Condition

This calculation is QA condition 1 because it serves as the basis for the qualification of a QA condition 1 structure, system or component.

Analysis Methods Used

This condition will also be evaluated using Generic Letter 91-18 section 6.14 (Flaw Evaluation). Paragraph's 3 and 4 state that moderate energy Class 3 piping (maximum operating temperature less than 200 degrees F and a maximum operating pressure less than 275 psig) may be evaluated using Generic Letter 90-05.

References

1. For Piping Analysis Calculations, see Table 1
2. NRC Generic Letters 90-05 and 91-18
3. ASME Code Case N-480
4. NUREG/CR-4572
5. For weld isometric see Table 2
6. Vector Mechanics for Engineers: Statics & Dynamics, by Beer and Johnston

Assumptions

Listed as used in body of calculation

Characterization

The following case was considered based on attachment 2A of this calculation. For this case the flaw was assumed to be thru-wall for the entire length.

Case 1 - considers a 4" sch 40 pipe with 3-0.375" flaws located 3" apart.

Evaluation

Per section C, part 3, of generic letter 90-05, the structural integrity of a through wall crack like flaw may be evaluated using, part 3.a ("Through-Wall Flaw" Approach). The following is an evaluation using this method except as noted below.

Since the flaw consists mainly of a subsurface void, it was assumed to be thru-wall for the entire length, therefore the maximum diameter of the void will be used for "2a", and nominal thickness will be used for "tmin".

Based on the maximum size of the flaw (3/8"), and the minimum distance apart of 3", these flaws were considered far enough apart to be considered separately.

The existing stresses for each weld location are tabulated on sheet 5. These stresses were taken from the existing Superpipe Analysis Runs for the problems listed in Table 1 (see sheet 4). The maximum ASME Section III Equation's 8, 9, 10 and 9E stresses and ratio's are listed. The Equation 9E stresses at Catawba are used to evaluate functionality by comparing faulted stresses too an Emergency allowable.

Evaluation (cont.)

The stress to be used for the 90-05 evaluation will be the summation of the maximum thermal stress (EQ 10), plus the maximum pressure stress, gravity stress and SSE earthquake stress. The above 90-05 stresses (Eq 10 thermal + pressure + weight + SSE inertia + SSE SAM's) were then manipulated to determine the maximum bending moment. This moment was then used to calculate the 90-05 bending stress using the section modulus at the extreme fiber. The 90-05 pressure stress was then conservatively calculated using PD/4t. These stresses were added together to determine the total 90-05 stress. The above case was evaluated using the maximum stress from all weld locations (see sheet 5).

To qualify the existing ASME Section III stresses, the section modulus of the cracked section "Zc" and the area of the cracked section "Ac" was calculated (see sheet 11). The equations used to calculated the section properties are derived on sheets 7 through 9. The existing maximum stress ratio's for ASME Section III Equations 8, 9, and 9E were factored by the larger of (Zun "uncracked" / Zc "cracked") or (Aun "uncracked" / Ac "cracked") (see sheet 6 for calculations) The existing maximum ratio for ASME Section III Equation 10 was not factored since generic letter 90-05 requires that a code repair be perform at the next scheduled outage, making the evaluation of a secondary thermal stress of little concern, especially from a fatigue standpoint.

Conclusion

Since the piping is made of austenitic stainless steel, the critical stress intensity factor K will be 135.0 ksi(in)^0.5 (ref. Generic Letter 90-05). Since the stress intensity factor K for this case, calculated on sheet 6 is less than the critical value, the requirements of generic letter 90-05 have been meet, except as previously noted. The ASME Section III Equations for primary stresses are also acceptable since the factored ratio's are less than 1.0.

Table 1

Prob. No.	Micro Fiche Attach	Superpipe Run		Calculation File No.	Calculation Rev. No.
		Date	Time		
3RN	M6	02-20-91	17:20:33	CNC-1206.02-84-2023	19
4RN	M8	08-22-91	15:28:48	CNC-1206.02-84-2019	17
6RN	M9	02-27-91	11:54:34	CNC-1206.02-84-2015	26

Table 3

Weld #'s	Nominal Diameter	Schedule	Wall Thickness
0RN-187-2	4"	40	0.237
0RN-187-22	4"	40	0.237
0RN-187-43	4"	40	0.237
0RN-187-44	4"	40	0.237
0RN-187-5	4"	40	0.237
0RN-187-7	4"	40	0.237
0RN-189-15	4"	40	0.237
0RN-189-16	4"	40	0.237
0RN-189-7	4"	40	0.237
0RN-191-14	4"	40	0.237
0RN-191-4	4"	40	0.237
0RN-196-18	4"	40	0.237
0RN-196-23	4"	40	0.237
0RN-200-3	4"	40	0.237
0RN-222-2	4"	40	0.237
0RN-223-3	4"	40	0.237
0RN-224-12	4"	40	0.237
0RN-224-15	4"	40	0.237
0RN-224-2	4"	40	0.237
0RN-224-6	4"	40	0.237
0RN-226-15	4"	40	0.237
0RN-227-10	4"	40	0.237

Table 2

Weld Isomtric Drawing Numbers	Drawing Revision Number
CN-0RN-187	7
CN-0RN-189	3
CN-0RN-191	6
CN-0RN-196	10
CN-0RN-200	8
CN-0RN-222	0
CN-0RN-223	0
CN-0RN-224	2
CN-0RN-226	2
CN-0RN-227	0

Existing Butt Welded Stresses

Weld #'s	Prob. No.	Micro Fiche Attach.	Superpipe Run Date	Superpipe Run Time	DCP	SOP	Press. pd/d, pd4t	Press.	Section Modulus Mean/Extr	Eq 8 Stress Ratio	Eq 9 Stress Ratio	Eq 10 Stress Ratio	Eq 9E Stress Ratio	Thermal Eq 10 Stress	Pres+Wt +SSE Stress	Total Stress	SIF
0RN-187-2	6RN	M9	02-27-91	11:54:34	C10A	108L	pd/d	115	mean	0.029	0.039	0.345	0.035	9684	1141	10825	1.8
0RN-187-5	6RN	M9	02-27-91	11:54:34	109	113R	pd/d	115	mean	0.068	0.111	0.279	0.105	7845	3482	11327	1.8
0RN-187-7	6RN	M9	02-27-91	11:54:34	C09A	114L	pd/d	115	mean	0.068	0.101	0.198	0.093	5563	3070	8633	1.8
0RN-187-22	6RN	M9	02-27-91	11:54:34	D08A	123L	pd/d	115	mean	0.052	0.116	0.167	0.120	4695	3944	8639	1.8
0RN-187-43	6RN	M9	02-27-91	11:54:34	E07A	41L	pd/d	115	mean	0.053	0.142	0.046	0.151	1284	4998	6282	1.8
0RN-187-44	6RN	M9	02-27-91	11:54:34	D07B	37R	pd/d	115	mean	0.047	0.118	0.025	0.125	707	4106	4813	1.8
0RN-189-7	6RN	M9	02-27-91	11:54:34	370	206R	pd/d	115	mean	0.072	0.090	0.451	0.078	12648	2553	15201	1.8
0RN-189-15	6RN	M9	02-27-91	11:54:34	1501	208L	pd/d	115	mean	0.078	0.121	0.274	0.114	7683	3733	11416	1.8
0RN-189-16	6RN	M9	02-27-91	11:54:34	1503	210R	pd/d	115	mean	0.074	0.135	0.209	0.132	5858	4374	10232	1.8
0RN-191-4	6RN	M9	02-27-91	11:54:34	C06B	26R	pd/d	115	mean	0.053	0.096	0.060	0.094	1671	3104	4775	1.8
0RN-191-14	6RN	M9	02-27-91	11:54:34	1001	14L	pd/d	115	mean	0.043	0.066	0.057	0.062	1612	2029	3641	1.8
0RN-196-18	3RN	M6	02-20-91	17:20:33	520	86L	pd/d	115	mean	0.056	0.092	0.135	0.088	3790	2891	6682	1.8
0RN-196-23	3RN	M6	02-20-91	17:20:33	496	85	pd/d	115	mean	0.060	0.097	0.144	0.092	4039	3033	7072	1.8
0RN-200-3	4RN	M8	08-22-91	15:28:48	C06B	14R	pd/d	115	mean	0.080	0.073	0.133	0.053	3743	1725	5468	1.8
0RN-222-2	3RN	M6	02-20-91	17:20:33	C52B	322R	pd/d	115	mean	0.029	0.040	0.162	0.036	4544	1183	5727	1.8
0RN-223-3	3RN	M6	02-20-91	17:20:33	F40B	230R	pd/d	115	mean	0.047	0.080	0.246	0.077	6911	2541	9453	1.8
0RN-224-2	6RN	M9	02-27-91	11:54:34	1505	472L	pd/d	115	mean	0.047	0.113	0.131	0.118	3684	3900	7585	1.8
0RN-224-6	6RN	M9	02-27-91	11:54:34	1510	478R	pd/d	115	mean	0.107	0.139	0.070	0.122	1956	4010	5966	1.8
0RN-224-15	6RN	M9	02-27-91	11:54:34	*2	486R	pd/d	115	mean	0.049	0.114	0.148	0.118	4165	3909	8075	1.8
0RN-226-15	6RN	M9	02-27-91	11:54:34	*1	418R	pd/d	115	mean	0.052	0.147	0.162	0.159	4543	5220	9763	1.8
0RN-227-10	6RN	M9	02-27-91	11:54:34	1205	444R	pd/d	115	mean	0.028	0.099	0.267	0.110	7483	3628	11111	1.8
0RN-224-12	6RN	M9	02-27-91	11:54:34	C64B	492W	pd/d	115	mean	0.046	0.118	0.086	0.125	2400	4122	6522	1.8
									Max	0.107	0.147	0.451	0.159	Maximum Stress		15201	1.8
									SIF at Max	1.8	1.8	1.8	1.8	SOP number at location of maximum			

stress =	206R
Thermal EQ 10	12648
Press+Wt+SSE	2553
Pressure Term	pd/d
Pressure	115
Section Mod.	mean

Notes: *1. Weld is located between C58B and C59A.
*2. Weld is located between C63B and C64A.

	Rev.	Pref.	Date	Check	Date
Catawba Nuclear Station Units 1 & 2	0	[signature]	5-1-95	[signature]	5-1-95
90-05 Eval. of Flawed RN Butt Welds					
Calc. File No. CNC-1206.00-02-0007					
Page 5 Attachment 3					

Thru-Wall Flaw Evaluation Using Generic Letter 90-05 for Butt Welding Pipe

Pipe Mean Radius (in)	Pipe O. D. (in)	Nom. Wall Thickness (in)	Code tmin See note 3 (in)	One Half Total Crack Length (in)	c	r	A	B
2.1315	4.500	0.237	0.237	0.1875	0.0280	8.994	5.7599	-11.7608
Enter 1 for carbon steel and 2 stainless steel					2			
C	Piping Stress ksi (Note 2)	F	Stress Intensity K	Allowble Stress Intensity	Ratio			
19.5445	9.57	1.0255	10.55	135	0.08			
Superpipe pressure stress-Enter 1 for Pd^2/(D^2-d^2) or 2 for PD/4t				1				
Superpipe section modulus-enter 1 for mean or 2 extreme fiber				1	Existing SIF	1.8		
Existing Superpipe EQ 10 Stress	Existing Superpipe EQ 9E stress	Existing Pressure (P)	Existing Pressure Stress	Exist. EQ 9E Bending Stress	Existing Bending Moment	90-05 Bending Stress	90-05 Pressure Stress	Total 90-05 Stress
12648	2553	115	461.23	2091.77	29010.81	9025.01	545.89	9570.90
Is the total crack length less than 3".				Yes	N/A			
Is the total crack length less than 15 percent of the pipe circumference.				Yes	N/A			

Evaluation of Existing Stresses Using the Cracked Section

See sheet for calculation of cracked section modulus (Zc).					Cracked Zc (in^3)	Uncracked Zun (in^3)	Ratio Zun/Zc	Cracked Area Ac (in^2)
r (in)	ri (in)	t (in)	I Cracked (in^4)	I Uncracked (in^4)				
2.1315	2.0130	0.2370	6.4500	7.2326	2.7800	3.3827	1.2168	2.9210
Uncracked Area Aun (in^2)	Ratio Aun/Ac	Maximum Ratio	ASME Equation Number	Existing Ratio	Cracked Ratio			
3.1740	1.0866	1.2168	8	0.107	0.130			
			9	0.147	0.179			
			9E	0.159	0.193			

Notes
1. For acceptance see sheet N/A.
2. See sheet 5 for existing stresses.
3. Used pipe nominal wall thickness see sheet 2.
4. This evaluation assumed the flaw was thru-wall for the entire length.

Rev.	Orig	Date	Check	Date
0	97w	5-1-95	JTG / OWO	5/1/95 5/1/95

Catawba Nuclear Station, Unit 1 & 2
90-05 Evaluation of Flawed RN Butt Welds
Calc File # CNC-1206.00-02-0007
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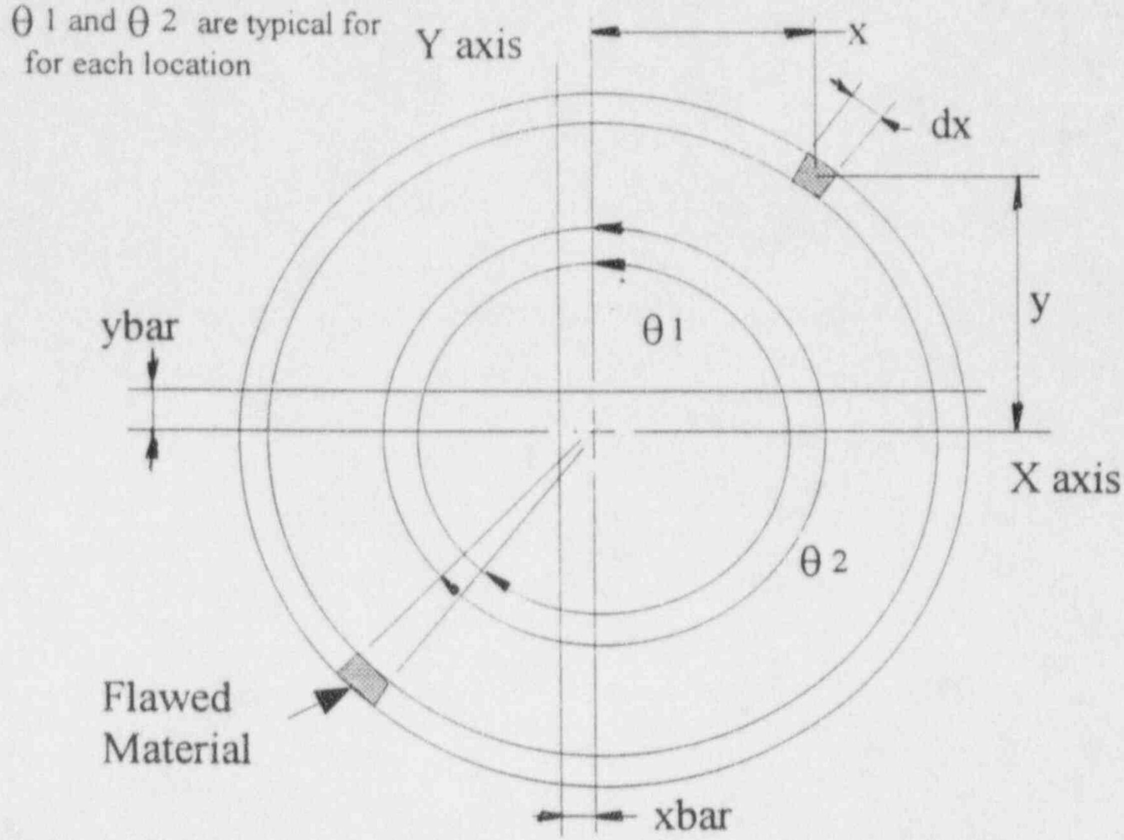


Derivation of formulas used to calculate Section Properties

dx = arc length for rotation $d\theta$

$da = t\,dx = t\,r\,d\theta$, where t = thickness, r = mean radius

θ_1 = angle in radians at the start of each flaw.

θ_2 = angle in radians at the end of each flaw.

δ Area for the section from θ_2 to θ_1 = $\int_{\theta_1}^{\theta_2} t\,r\,d\theta$ = $rt\theta_2 - rt\theta_1$

δ first area moment about the X axis for the section from θ_2 to θ_1 = $\int y\,da = \int_{\theta_1}^{\theta_2} rt\,d\theta\, r\cos\theta = r^2 t \int_{\theta_1}^{\theta_2} \cos\theta\, d\theta$

(cont.)

Catawba Nuclear Station Unit 1 & 2 90-05 Evaluation of Flawed RN Piping Calc. File # CNC-1206.00-02-0007 Page 7 , Att. 3	Rev.	Perf.	Date	Check	Date
	0	GFW	5-1-95	JTC	5/1/95

(cont. from previous sheet)

$= r^2 t (\sin\theta_2 - \sin\theta_1)$

δ first area moment about the y axis for the section from θ_2 to θ_1 $= \int x\,da = \int_{\theta_1}^{\theta_2} rt\,d\theta\, r\sin\theta = r^2 t \int_{\theta_1}^{\theta_2} \sin\theta\, d\theta$

$= r^2 t \left(-\cos\theta_2 - (-\cos\theta_1)\right)$

Moment of Inertia about the X axis

δI_x for the section from θ_2 to θ_1 $= \int y^2 da$

$= \int_{\theta_1}^{\theta_2} r^2 \cos^2\theta\, tr\,d\theta = r^3 t \int_{\theta_1}^{\theta_2} \cos^2\theta\, d\theta$

$= r^3 t \left(\left(\frac{\theta_2}{2} + \frac{\sin\theta_2 \cos\theta_2}{2} \right) - \left(\frac{\theta_1}{2} + \frac{\sin\theta_1 \cos_1}{2} \right) \right)$

Moment of Inertia about the Y axis

δI_y for the section from θ_2 to θ_1 $= \int x^2 da$

$= \int_{\theta_1}^{\theta_2} r^2 \sin^2\theta\, tr\,d\theta = r^3 t \int_{\theta_1}^{\theta_2} \sin^2\theta\, d\theta$

$= r^3 t \left(\left(\frac{\theta_2}{2} - \frac{\sin\theta_2 \cos\theta_2}{2} \right) - \left(\frac{\theta_1}{2} - \frac{\sin\theta_1 \cos\theta_1}{2} \right) \right)$

Product of Inertia about the x-y axis

δI_{xy} for the section from θ_2 to θ_1 $= \int xy\,da$

$= \int_{\theta_1}^{\theta_2} r\sin\theta\, r\cos\theta\, tr\,d\theta = r^3 t \int_{\theta_1}^{\theta_2} \sin\theta \cos\theta\, d\theta$

$= r^3 t \left(\frac{\sin\theta_2^2}{2} - \frac{\sin\theta_1^2}{2} \right)$

Total Area = Summation of δ area's

(cont.)

(cont. from previous sheet)

First Area Moment x and y = summation of δ area moments

$$ybar = \frac{\text{First Area Moment about the x axis}}{\text{Total Area}}$$

$$xbar = \frac{\text{First Area Moment about the y axis}}{\text{Total Area}}$$

$$I_{xbar} = I_x - (\text{Total Area})(ybar)^2$$

$$I_{ybar} = I_y - (\text{Total Area})(xbar)^2$$

$$I_{xybar} = I_{xy} - (\text{Total Area})(xbar)(ybar)$$

Principal Moments of Interia

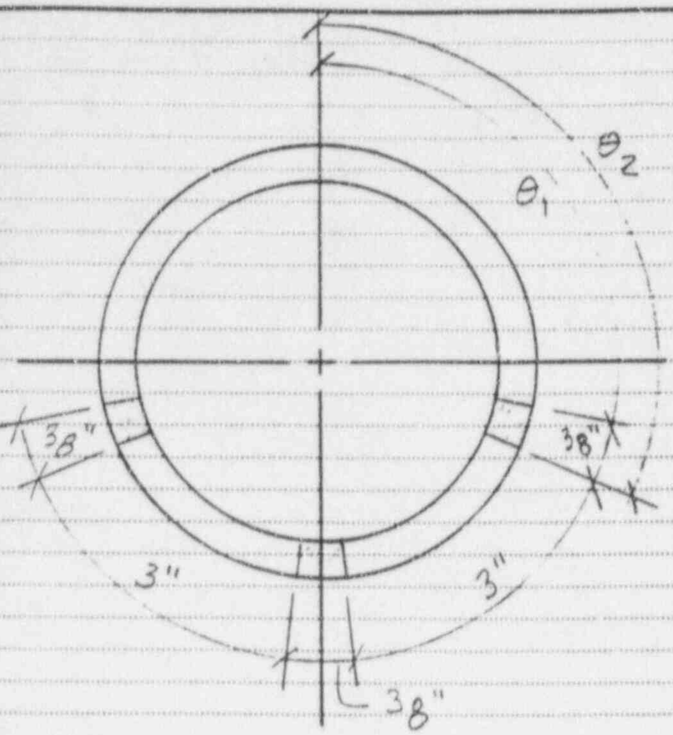
$$I_{min}, I_{max} = \frac{I_{xbar} + I_{ybar}}{2} \pm \sqrt{\left(\frac{I_{xbar} - I_{ybar}}{2}\right)^2 + (I_{xybar})^2}$$

$$Z = \frac{I}{c}$$

Principal Section Modulus

$$Z_{min}, Z_{max} = \frac{I(min, max)}{O.D/2 + \sqrt{(ybar)^2 + (xbar)^2}}$$

Ref: Vector Mechanics for Engineers: Statics & Dynamics, by Beer & Johnston



4" Butt Weld Section

$arc = R\theta \quad R = D/2 \quad \theta = \frac{arc}{D/2}$

$\theta = \frac{2\,arc}{D}$

$\theta_{3/8"} = \frac{2 \times .375}{4.5} = 0.1667$ rads

$\theta_{3"} = \frac{2 \times 3}{4.5} = 1.3333$ rads

$\theta_1 = 0$

$= (2\pi - \theta_{3/8} \times 3 - \theta_3 \times 2)/2$

$\theta_2 = 1.5582$ rad

$\theta_2 = 1.5582 + .1667 = 1.7249$

$\theta_2 = 1.7249 + 1.3333 = 3.0582$

$\theta_2 = 3.0582 + .1667 = 3.2249$

$\theta_2 = 3.2249 + 1.3333 = 4.5582$

$\theta_2 = 4.5582 + .1667 = 4.7249$

$\theta_2 = 4.7249 + 1.5582 = 6.2831$

Calculation of Section Properties for Flawed Section

Angle 1 θ Radians Note 3	Angle 2 θ Radians Note 3	δ θ Radians	Wall Thick. (in)	O. D. (in)	Mean Radius (in)	δ Area (in)	δ First Area Moment x (in^3)	δ First Area Moment y (in^3)	δ Ix (in^4)	δ Iy (in^4)	δ Ixy (in^4)
0.000	1.558	1.558	0.237	4.500	2.132	0.787	1.077	1.063	1.803	1.774	1.147
1.558	1.725	0.167	0.000	4.500	2.250	0.000	0.000	0.000	0.000	0.000	0.000
1.725	3.058	1.333	0.237	4.500	2.132	0.674	-0.974	0.908	1.609	1.451	-1.113
3.058	3.225	0.167	0.000	4.500	2.250	0.000	0.000	0.000	0.000	0.000	0.000
3.225	4.558	1.333	0.237	4.500	2.132	0.674	-0.974	-0.908	1.609	1.451	1.113
4.558	4.725	0.167	0.000	4.500	2.250	0.000	0.000	0.000	0.000	0.000	0.000
4.725	6.283	1.558	0.237	4.500	2.132	0.787	1.077	-1.063	1.802	1.774	-1.147

Total Area (in)	First Area Moment x (in^3)	First Area Moment y (in^3)	Ix (in^4)	Iy (in^4)	Ixy (in^4)
2.921	0.205	-0.000	6.823	6.450	-0.000

ybar (in)	xbar (in)	Ixbar (in^4)	Iybar (in^4)	Ixybar (in^4)
0.070	-0.000	6.809	6.450	-0.000

Imin (in^4)	Imax (in^4)	Zmin (in^3)	Zmax (in^3)
6.450	6.809	2.780	2.935

Notes

1. Zmin. and Zmax. are calculated using Imin. and Imax with c equal to the radius to O. D. plus the resultant of ybar and xbar.
2. See sheets 7 thru 9 for forumlas used in the above calculations.
3. Angle 1 represents the angle at the start of flaw and Angle 2 represent the angle to the end of the flaw, for each flaw, see sketch on sheet 10.

Rev.	Perf.	Date	Check	Date
0	GJW	5-2-95	JTH	5/2/95

(Revision 7)

DESIGN ENGINEERING DEPARTMENT

OPERABILITY EVALUATION

Station: Catawba Unit: 1&2 PIR Number: 0-C95-0527

Structure, system, or component (SSC) in question: 4" RN Stainless Steel butt welds

Design basis reference application: FSAR volume 3, Table 3.2.2-3

Technical Specification section applicable: 3/4.4.10

Structural Integrity

The SSC in question is recommended to be:

X OPERABLE ___ CONDITIONALLY OPERABLE ___ INOPERABLE

Operability Evaluation expiration date: ________

FSAR change required _YesXNo 10 CFR 50.59 Evaluation required_YesXNo

Summary/Comments:

The 4" RN Stainless Steel butt welds had no safety significance issues during the investigation period of the pin hole leaks, per NRC 90-05 calculation, CNC-1206.00-02-0007. The leaking RN connnections will be replaced or repaired per a repair plan. The repair plan will be initiated as soon as possible, but will not force the system availability. The RN socket welds are operable with these leaks.

Originated by: Ernie McElroy Date: 05-02-95

Reviewed by: ________________ Date: ________

Approved by: ________________ Date: ________