

NORTHEAST UTILITIES SERVICE COMPANY
NUCLEAR ENGINEERING AND OPERATIONS GROUP
GENERATION MECHANICAL ENGINEERING

PAGE 1 OF 22

PLUS 10 PGS ATTACHED

ASME SECTION III CLASS 2 AND 3
AND ANSI B31.1.0 PIPING ANALYSIS

PROJECT ASSIGNMENT: 85-127CALCULATION NUMBER: 8- 7-1013-GPPLANT: MILLSTONE UNIT 3

TITLE: EVALUATION OF ERODED SERVICE
WATER JOINTS ON 1 1/2" CU-N₂ PIPING
FOR STRUCTURAL INTEGRITY

QA CATEGORY 1

REVISION 0

PREPARED BY <u>Steve V Dumas</u>	DATE <u>11-15-88</u>	REVIEWED BY <u>David L Polunin</u>	DATE <u>11-18-88</u>
REVIEW METHOD <u>FULL REVIEW PER NE&O 5.06</u>		APPROVED BY <u>THOMAS J. LAWSON</u>	DATE <u>11/18/88</u>

REVISION 1

PREPARED BY	DATE	REVIEWED BY	DATE
REVIEW METHOD		APPROVED BY	DATE

REVISION 2

PREPARED BY	DATE	REVIEWED BY	DATE
REVIEW METHOD		APPROVED BY	DATE

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>AVD</u>	DATE <u>10-24-88</u>
<u>WATER JOINTS ON 1 1/2" CU-NI PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-1013 GP</u>	REV. <u>0</u>
	SHEET NO. <u>2</u>	OF <u>22</u>

TABLE OF CONTENTS

	Pg.
TITLE PAGE	1
TABLE OF CONTENTS	2
OBJECTIVE	3-4
REFERENCES	5
ANALYSIS - LOCATION, LOADS	6
LOADINGS, COMBINATIONS, ALLOWABLES	7
PIPING PROPERTIES, WALL LOSS, MODEL	8-11
STRESSES - BENDING	12-14
AXIAL	15
SHEAR	16-18
PRESSURE BOUNDARY, BUCKLING, FRACTURE	19-20
SUMMARY	21
CONCLUSIONS	21-22
ATTACHMENTS	A1
1. LOAD TABULATION	A2-A3
2. LIST OF ERODED JOINTS	A4
3. EROSION INFO	A5-A9

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED</u> <u>SERVICE WATER JOINTS ON 1 1/2"</u> <u>CU-N₂ PIPING</u> <u>MP3</u>	BY <u>AVD.</u> DATE <u>11-15-88</u> CHKD. BY <u>DLC</u> DATE <u>11-18-88</u> CALC. NO. <u>85-127-1013 GP</u> REV. <u>0</u> SHEET NO. <u>3</u> OF <u>22</u>
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OBJECTIVE

TO EVALUATE THE STRUCTURAL INTEGRITY OF A GROUP OF ERODED SERVICE WATER PIPING JOINTS. THE FOLLOWING IS A LISTING OF THE JOINTS TO BE QUALIFIED IN THIS CALCULATION.

TABLE 1

<u>ISO</u>	<u>WELD</u>	<u>LINE</u> [*]	<u>CALC</u>	<u>DATA</u>	<u>NCR</u>
		<u>3SWP-150-X-3</u>	<u>12179-NP(F)-</u>	<u>PT.</u>	
CP319009	FW 19	X= 064	621-XD	247	3-88-106
CP319031	FW 4 [*]	064		350	3-88-170
	FW 9	064		260	3-88-168
	FW 13	064		330	3-88-169
CP319033	FW 1-1	071	627-XD	1220	3-88-105
CP319010	FW 6	071		780	3-88-167
CP319011	FW 2-1	061	622-XD	1115	3-88-108
	FW 4 [*]	061		1102	3-88-165
CP319030	FW 2	061		1122	3-88-108
	FW 4	061		1120	3-88-108
CP319008	FWS2	072	687-XD	204	3-88-104
CP319732	FW 4	103	923-XD	140	3-88-139
	FW 2	103		155	3-88-138

* INDICATES CURRENT THROUGH-WALL EROSION

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT EVALUATION OF ERODED SERVICE BY LVD DATE 10-17-88
WATER JOINTS ON 1½" CU. N. PIPING CHKD. BY DL DATE 1-18-88
MP3 CALC. NO. 85-127-1013 GP REV. 0
SHEET NO. 4 OF 22

OBJECTIVE CONT'D

ALL PIPING IS QA CATE DRY I LOCATED IN THE AUXILIARY AND E.S.F BUILDINGS. THIS PIPING SERVICES THE CHARGING PUMP (CCE) AND SAFETY INJECTION (CCI) COOLERS.

THIS EVALUATION WILL CONSIDER THE PRESENT CONDITION OF THE PIPING AND APPLY MARGINS TO ALLOW FOR FURTHER EXPECTED DEGRADATION TO YIELD A SET OF BOUNDING CONDITIONS FOR HOLE SIZE AND PIPE WALL THICKNESS. THESE VALUES WILL BE USED AS ALLOWABLES, AND IF NOT EXCEEDED WILL BE CONSIDERED ACCEPTABLE FOR ALL ERODED AREAS PER THE QUALIFICATION PROVIDED HERE-IN.

ALL PRIMARY PIPE LOADINGS FOR EACH POINT LISTED IN TABLE 1 WILL BE ENVELOPED TO DETERMINE MAXIMUM FORCES AND MOMENTS IN EACH INDIVIDUAL DIRECTION. THESE LOADS WILL BE COMBINED AND EVALUATED PER THE ASME CODE (REF. 1) AND THE ORIGINAL DESIGN CRITERIA (REF. 2) FOR MILLSTONE UNIT 3. PIPING LOADS ARE EXTRACTED FROM THE STRESS ANALYSIS CALCULATIONS OF RECORD. (REF. 3)

PROPERTIES OF THE PIPING IN THE ERODED CONDITION WILL BE CALCULATED USING EQUATIONS FROM ROARK (REF. 4)

THIS CALCULATION SUPPORTS PLANT REQUESTS TO DEMONSTRATE THAT THE SERVICE WATER LINES ARE CAPABLE OF PERFORMING THEIR INTENDED FUNCTION BY MAINTAINING STRUCTURAL INTEGRITY IN THE ERODED CONDITION. THIS REQUEST IS DOCUMENTED VIA NCR'S FROM MP3 ENGINEERING AS LISTED IN TABLE 1.

THE PROBABLE CAUSE OF THE PIPING EROSION IS TURBULENCE OF THE WORKING FLUID AT FLOW PATH CHANGES (ELBOWS, TEES) CAUSED BY EXCESSIVE FLOW VELOCITIES.

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>L.V.D</u>	DATE <u>10-18-88</u>
<u>WATER JOINTS ON 1½" CU-NI PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-1013 GA</u>	REV. <u>0</u>
	SHEET NO. <u>5</u>	OF <u>22</u>

REFERENCES

1. ASME SECTION III 1971 ED. THROUGH SUMMER 1973 ADDENDA
 - a. " " VIII 1974 ED. TABLE UNF 23.2
2. NETM 44 "PIPE STRESS ANALYSIS CRITERIA DOCUMENT-MILLSTONE NUCLEAR POWER STATION-UNIT 3" REV. 2 INCLUDING CHANGE NOTICES.
3. S&W STRESS CALCULATIONS - ALL INCLUDING CHANGE NOTICES

A.	12179-NP(F)-621-XD	REV. 4
B.	- 622-XD	3
C.	- 627-XD	2
D.	- 687-XD	1
E.	- 923-XD	2
4. "FORMULAS FOR STRESS AND STRAIN" 5TH ED. ROARK & YOUNG
5. AISC HANDBOOK 8TH ED.

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT EVALUATION OF ERODED SERVICE
WATER JOINTS ON 1½" CU-N. PIPING
MP3

BY A.V.D. DATE 10-20-88
 CHKD. BY DLC DATE 11-18-88
 CALC. NO. 85-127-1013 GP REV. 0
 SHEET NO. 6 OF 22

ANALYSIS

LOCATION OF EVALUATION

THE AREAS EXPERIENCING EROSION ARE IDENTIFIED BY ISOMETRIC #, FIELD WELD (FW), LINE #, STRESS CALCULATION AND STRESS DATA POINT LOCATION ON THE PIPE STRESS WORKSKETCH. THIS INFORMATION IS SUMMARIZED IN TABLE 1. ALSO SEE ATTACHMENT 2.

LOADS

LOADS ARE EXTRACTED FROM THE NUPIPE-SW RUN OF RECORD FOR THE LATEST REVISION OF THE STRESS CALCULATIONS (REF. 3)

FOR COMPUTER RUN NUMBERS, DATES, AND A TABULATION OF ALL APPLICABLE FORCES & MOMENTS, SEE ATTACHMENT 1.

THE FOLLOWING TABLE SUMMARIZES THE MAXIMUM ENVELOPED VALUES IN EACH DIRECTION FROM ATTACHMENT 1.

PRIMARY LOADS

LOCAL COORDINATES

TABLE 2

LOAD CASE	FORCES (LBS)			MOMENTS (FT-LBS)		
	F _x	F _y	F _z	M _x	M _y	M _z
DEADLOAD	25*	58	26	13	8*	10
OBE INERTIA	22*	68	32	39	23	40
OBE ANCHOR	4	3	9	2	1	4
SSE INERTIA	28*	60	28	33	31	54
SSE ANCHOR	3	2	6	2	2	2

NO TIME HISTORY EVENTS AFFECT THIS PORTION OF THE SWP SYSTEM
 * THESE FORCES + MOMENTS TAKEN FROM AN ERODED JOINT THAT WAS REPAIRED

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>AVD</u>	DATE <u>10-20-88</u>
<u>WATER JOINTS ON 1½" Cu-Ni PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-10136P</u>	REV. <u>0</u>
	SHEET NO. <u>7</u>	OF <u>22</u>

ANALYSIS CONT'D

TO SHOW STRUCTURAL INTEGRITY OF THE PIPING IS MAINTAINED IN THE ERODED CONDITION, THE PIPING WILL BE QUALIFIED FOR:

MECHANICAL LOADINGS

1. BENDING MOMENTS
2. AXIAL TENSION/COMPRESSION
3. SHEAR LOADS AND TORSION

THESE LOADINGS WILL BE QUALIFIED USING THE FOLLOWING

LOAD COMBINATIONS (REF. 2)

- | | |
|------------|-----------------------------------|
| A. NORMAL | PRESSURE + DEADLOAD |
| B. UPSET | PRESSURE + DEADLOAD + OBEI + OBEA |
| C. FAULTED | PRESSURE + DEADLOAD + SSEI + SSEA |

ALLOWABLES

PIPE MATERIAL <u>SB 466 CDA 706</u>	Sc = 8700 psi (REF. 3)
(REF. 3)	Sh = 8700 psi
	Sy = 13000 psi
	Su = 38000 psi
	↓ REF 1b ↓
I. NORMAL	1.0 Sh = 8700 psi
II. UPSET	1.2 Sh = 10440 psi
III. FAULTED	2.4 Sh = 20880 psi

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>J.V.D.</u>	DATE <u>10-21-88</u>
<u>WATER JOINTS ON 1½" Cu-Ni PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-1013GP</u>	REV. <u>0</u>
	SHEET NO. <u>8</u>	OF <u>22</u>

ANALYSIS CONT'D

MODIFIED PIPING PROPERTIES

THE PIPING PROPERTIES OF THE ERODED PIPE AREAS ARE CALCULATED BELOW TO ALLOW MARGINS FOR FUTURE EROSION. ^{THIS} WILL QUALIFY THE SYSTEM UNTIL SUCH TIME THAT THESE LIMITS ARE EXCEEDED OR THE PIPING IS PERMANENTLY REPAIRED.

ULTRASONIC (U.T.) AND EDDY CURRENT (ECT) TESTING DATA IS AVAILABLE FOR THE ^{SOME} ERODED JOINTS THAT HAVE NOT PROGRESSED TO THROUGH-WALL LEAKS (ATTACHMENT 3)

FOR JOINTS CURRENTLY LEAKING, NO TEST DATA IS AVAILABLE AND ONCE DATA IS TAKEN THE ACCEPTABILITY OF THE JOINT WILL BE DETERMINED.

WALL LOSS

THERE ARE TWO AREAS OF CONCERN WITH THE ERODED PIPE.

1. SIZE OF THROUGH-WALL HOLE

2. WALL THICKNESS LOSS AROUND PERIMETER OF HOLE

TO QUALIFY AN ENVELOPED CONDITION FOR ALL 1½" PIPE JOINTS, THIS EVALUATION WILL ATTEMPT TO SHOW THE FOLLOWING LIMITS ARE ACCEPTABLE.

A. ALLOWABLE HOLE DIAMETER = 3/4"

B. ALLOWABLE WALL THICKNESS = .10" AT ANY POINT OUTSIDE HOLE

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT EVALUATION OF ERODED SERVICE
WATER JOINTS ON 1 1/2" CU-NI PIPING
MP3

BY AVD

DATE 10-21-88

CHKD. BY DLC

DATE 11-18-88

CALC. NO. 85-127-1013 GP

REV. 0

SHEET NO. 9

OF 22

ANALYSIS CONT'D

MODIFIED PIPING PROPERTIES CONT'D

CALCULATING THE PROPERTIES OF THE REMAINING SECTION USING THE FORMULAS FROM ROARK (REF. 4) FOR A SECTOR OF HOLLOW CIRCLE (EQUATION 19, PG. 69) GIVES:

MOMENT OF INERTIA

$$I_1 = R^3 t \left[\left(1 - \frac{3t}{2R} + \frac{t^2}{R^2} - \frac{t^3}{4R^3} \right) \left(\alpha + \sin \alpha \cos \alpha - \frac{2 \sin^2 \alpha}{\alpha} \right) + \frac{t^2 \sin^2 \alpha}{3R^2 \alpha (2 - t/R)} \left(1 - \frac{t}{R} + \frac{t^2}{6R^2} \right) \right]$$

WHERE α = HALF ANGLE OF REMAINING SECTION (RADIAN)
 t = WALL THICKNESS OF REMAINING SECTION
 R = OUTSIDE RADIUS

C-CENTROID TO OUTER FIBER DIMENSION

C - GREATER OF Y_{1a} OR Y_{1b} WHERE

$$Y_{1a} = R \left[1 - \frac{2 \sin \alpha}{3 \alpha} \left(1 - \frac{t}{R} + \frac{1}{2 - t/R} \right) \right] \quad \text{DISTANCE BELOW CENTROID (REF. 4)}$$

$$Y_{1b} = R \left[\frac{2 \sin \alpha}{3 \alpha (2 - t/R)} + \left(1 - \frac{t}{R} \right) \frac{2 \sin \alpha - 3 \alpha \cos \alpha}{3 \alpha} \right] \quad \text{DISTANCE ABOVE CENTROID (REF. 4)}$$

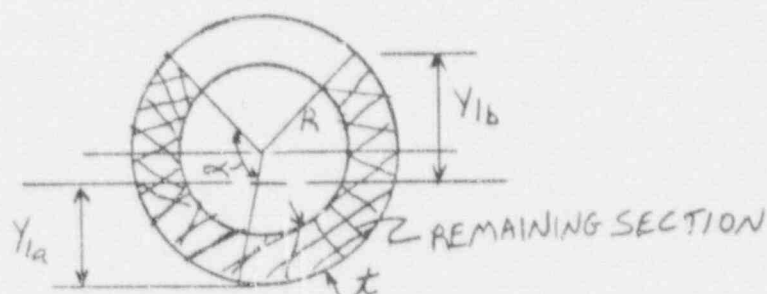
WITH α, R & t AS DEFINED ABOVE

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>J.V.D</u>	DATE <u>10-21-88</u>
<u>WATER JOINTS ON 1/2" Cu-Ni PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-10136P</u>	REV. <u>0</u>
	SHEET NO. <u>10</u>	OF <u>22</u>

ANALYSIS CONT'D

MODEL



PIPE X-SECTION

WALL LOSS 1/2" Ø PIPE O.D. = 1.9" CIRCUMFERENCE $\pi d = 5.97"$

HOLE SIZE - 3/4" IN-PLANE = .76" PIPE SURFACE

$$\text{PIPE LOSS} = \frac{.76}{5.97} = 12.73\%$$

$$12.73\% \text{ OF } 360^\circ \text{ CIRCLE} = 46^\circ$$

$$\text{HALF ANGLE } \alpha = \frac{360-46}{2} = 157^\circ = 2.74 \text{ RADIANS}$$

PIPE PROPERTIES - INPUT FOR ROARK

$$\alpha = 2.74 \text{ RADIANS}$$

$t = .10"$ MODIFIED - ASSUME UNIFORM WALL LOSS OVER REMAINING X-SECTION

$$R = \frac{1.9}{2} = .95"$$

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT EVALUATION OF ERODED SERVICE BY LV2 DATE 10-24-88
WATER JOINTS ON 1 1/2" CU-NI PIPING CHKD. BY DLC DATE 11-18-88
MP3 CALC. NO. 85-127-10136P REV. 0
 SHEET NO. 11 OF 22

ANALYSIS CONT'D

DETERMINE MOMENT OF INERTIA

$$I_1 = .166 \text{ IN}^4 \text{ FOR SECTOR OF A HOLLOW CIRCLE}$$

DETERMINE C DIMENSION

$$Y_{1a} = .821 \text{ IN.}$$

$$Y_{1b} = .911 \text{ IN.}$$

$$\therefore C = .911 \text{ IN.} \quad \text{DISTANCE FROM OUTER FIBER TO CENTROID OF HOLLOW CIRCULAR SECTOR}$$

DETERMINE LOADS

TO CALCULATE BENDING MOMENTS TO BE APPLIED TO THE MODIFIED PIPE CROSS SECTION

USING EQUATIONS A, B & C FROM PG. 7
 AND LOADS FROM PG. 6 TABLE 2

$$\text{COMBINING AS: } M_B = (M_{x_T}^2 + M_{y_T}^2 + M_{z_T}^2)^{1/2}$$

WHERE M_{x_T} = TOTAL MOMENT PER LOAD COMBINATION, ADDED ABSOLUTELY. M_y & M_z SIMILAR

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT EVALUATION OF ERODED SERVICE
WATER JOINTS ON 1½" CU-NI PIPING
MP3

BY AVD

DATE 10-24-88

CHKD. BY DLC

DATE 11-18-88

CALC. NO. 85-127-1013-4P

REV. 0

SHEET NO. 12

OF 22

ANALYSIS CONT'D

BENDING MOMENTS

i) NORMAL $M_{BN} = (13^2 + 8^2 + 10^2)^{1/2} = 19 \text{ FT-LB}$

$M_{BN} = 228 \text{ IN-LB}$

ii) UPSET $M_{BU} = (54^2 + 32^2 + 54^2)^{1/2} = 83 \text{ FT-LB}$

$M_{BU} = 996 \text{ IN-LB}$

iii) FAULTED $M_{BF} = (48^2 + 41^2 + 66^2)^{1/2} = 92 \text{ FT-LB}$

$M_{BF} = 1104 \text{ IN-LB}$

1. CALCULATE STRESS

FOR BENDING $\sigma_B = \frac{.75i M_{BC}}{I}$

FOR PRESSURE $\sigma_{SLP} = \frac{PD_o}{4t_m}$ $P = 100 \text{ PSI (REF. 3) LONGITUDINAL}$

FOR $t_m = .10"$

$\sigma_{SLP} = 475 \text{ PSI}$

FOR BENDING STRESSES (AVERAGE ACROSS X-SECTION)

$L = 2.1$ FOR SOCKET FITTINGS - ELBOWS & TEES

NORTHEAST UTILITIES SERVICE COMPANY

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<u>WATER JOINTS ON 1/2" Cu-Ni PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-10136P</u>	REV. <u>0</u>
	SHEET NO. <u>13</u>	OF <u>22</u>

ANALYSIS CONT'D

BENDING STRESS (AVERAGE)

A. NORMAL $\sigma_{BN} = \frac{.75(2.1)(228)(.911)}{.166}$ $\sigma_{BN} = 1971 \text{ psi}$

B. UPSET $\sigma_{BU} = \frac{.75(2.1)(996)(.911)}{.166}$ $\sigma_{BU} = 8609 \text{ psi}$

C. FAULTED $\sigma_{BF} = \frac{.75(2.1)(1104)(.911)}{.166}$ $\sigma_{BF} = 9543 \text{ psi}$

QUALIFY TO ASME EQUATIONS

NORMAL EQ. 8 $475 + 1971 = \underline{2446 \text{ psi}} < 8700 \text{ psi} \therefore \text{O.K.}$

UPSET EQ. 9_U $475 + 8609 = \underline{9084 \text{ psi}} < 10440 \text{ psi} \therefore \text{O.K.}$

FAULTED EQ. 9_F $475 + 9543 = \underline{10018 \text{ psi}} < 20880 \text{ psi} \therefore \text{O.K.}$

NORTHEAST UTILITIES SERVICE COMPANY

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<u>WATER JOINTS ON 1 1/2" Cu-Ni PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-1013GP</u>	REV. <u>0</u>
	SHEET NO. <u>14</u>	OF <u>22</u>

ANALYSIS CONT'D

BENDING STRESS (LOCAL)

TO QUALIFY THE PIPE WITH AN ASSUMED 3/4" HOLE (PG. 8) FOR LOCAL STRESS LEVELS AT THE DISCONTINUITY, APPLY SIF FOR AN UNREINFORCED TEE

$$SIF \ i = \frac{9}{h^{2/3}} \quad h = \frac{T}{R}$$

T = WALL THICKNESS = .10" MODIFIED
 R = PIPE MEAN RADIUS = $\frac{1.9 - .1}{2} = .90"$

$$i = 3.90$$

QUALIFYING TO AN ALLOWABLE OF $\frac{S_y + S_u}{2} = \frac{13000 + 38000}{2}$

ALLOW. = 25,500 psi

WHICH IS THE FLOW STRESS

THRESHOLD WHICH ALLOWS LIMITED PLASTIC DEFORMATION & STRAIN HARDENING. THIS IS ACCEPTABLE LOCALLY IN THE AREA OF THE EXISTING HOLE

QUALIFY WORST CASE (FAULTED) LOAD

$$EQ. 9_F = 475 \text{ psi} + \frac{(75)(3.90)(1104)(.911)}{.166} = 18197 \text{ psi}$$

*
18197 psi < 25500 psi ∴ ACCEPTABLE

* SUFFICIENT MARGIN EXISTS TO MEET THE ASME EQ. 9F ALLOW. OF 20880 psi

NORTHEAST UTILITIES SERVICE COMPANY

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BY J.V.D.

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CALC. NO. 85-127-1013 GP

REV. 0

SHEET NO. 15

OF 22

ANALYSIS CONT'D

2. AXIAL STRESS

$$\sigma_A = \frac{P}{A}$$

$P = F_{X_{LOCAL}}$ USING LOAD COMBINATION FROM PG. 7

$A =$ METAL AREA OF REMAINING X-SECTION

QUALIFY WORST CASE :

FAULTED $P = 56^{\#}$

$A = 7/8$ OF 1.9" O.D., .10" WALL PIPE

$$A = .493 \text{ IN}^2$$

$$\text{MAX } \sigma_A = \frac{56}{.493} = 114 \text{ psi}$$

∴ AXIAL STRESS ACCEPTABLE BY INSPECTION

NORTHEAST UTILITIES SERVICE COMPANY

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CALC. NO. 85-127-10136P

REV. 0

SHEET NO. 16

OF 22

ANALYSIS CONT'D

3. SHEAR STRESS

A. SHEAR FROM LATERAL FORCES

FROM MAX SHEAR THEORY $\sigma_v = \frac{2F_v}{A}$

WHERE $F_v = (F_{Y_L}^2 + F_{Z_L}^2)^{1/2}$ USING LOAD COMBINATION FROM PG. 7

$A = \text{METAL AREA} = .493 \text{ IN}^2$

	<u>LOAD</u>	<u>STRESS</u>
NORMAL	$F_{V_N} = (58^2 + 26^2)^{1/2} = 64.16$	260 psi
UPSET	$F_{V_U} = (129^2 + 67^2)^{1/2} = 146.16$	593 psi
FAULTED	$F_{V_F} = (120^2 + 60^2)^{1/2} = 135.16$	547 psi

B. SHEAR FROM TORSION

FOR TORSION $T = \sigma_v = k \frac{16TD}{\pi(D^4 - d^4)}$ (REF. 4)

WHERE $k = 1.0$ FOR AVERAGE τ ACROSS THE SECTION

$k = K_1 + K_2 \left(\frac{2r}{D}\right) + K_3 \left(\frac{2r}{D}\right)^2 + K_4 \left(\frac{2r}{D}\right)^3$ FOR LOCAL τ (AT HOLE)

$T = M_{x_T}$ LOCAL TORSIONAL MOMENT FROM PG. 6, TABLE 2

$r = \text{RADIUS OF HOLE } \frac{3/4}{2} = \frac{3}{8}"$

$D = \text{O.D. OF PIPE} = 1.9"$

$d = \text{I.D. OF PIPE} = 1.7"$

$K_1 = 4.0$

$K_2 = -6.793 + 1.133 \frac{d}{D} - .126 \left(\frac{d}{D}\right)^2$

$K_3 = 38.382 - 7.242 \frac{d}{D} + 6.495 \left(\frac{d}{D}\right)^2$

$K_4 = -44.576 - 7.428 \frac{d}{D} + 58.656 \left(\frac{d}{D}\right)^2$

NORTHEAST UTILITIES SERVICE COMPANY

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DATE 10-24-88

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DATE 11-18-88

CALC. NO. 85-127-10136A

REV. 0

SHEET NO. 17

OF 22

ANALYSIS CONT'D

TORSION CONT'D

EQUATION LIMITATIONS $\frac{d}{D} = .895 \leq .90$ O.K.

$\frac{2r}{D} = .395 \leq .40$ O.K.

ALLOWABLES

AVERAGE SHEAR $.4 S_y$ $.4(13000) = 5200 \text{ psi}$ REF. 5

LOCAL SHEAR $.8 S_y$ $= 13000 \text{ psi}$ REF. 1

C. SHEAR FROM HOOP STRESS

$$\sigma_H = \frac{PD_o}{2t_m} \quad \text{FOR } P=100 \text{ psi} \quad \sigma_H = 950 \text{ psi}$$

I. AVERAGE SHEAR ($k=1.0$)

TORSION:

NORMAL $T = M_{X_N} = (43 \text{ FT-LB})(12) = 156 \text{ IN-LB}$ LOAD STRESS 323 psi

UPSET $T = M_{X_U} = (54 \text{ FT-LB})(12) = 648 \text{ IN-LB}$ 1342 psi

FAULTED $T = M_{X_F} = (48 \text{ FT-LB})(12) = 576 \text{ IN-LB}$ 1193 psi

TOTAL AVERAGE SHEAR 3A+3B+3C (SECTIONS) WORST CASE

$$\sigma_{VA} = 593 + 1342 + 950$$

$$\sigma_{VA} = 2885 \text{ psi} < 5200 \text{ psi} \quad \therefore \text{ACCEPTABLE}$$

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>A.V.D.</u>	DATE <u>10-24-88</u>
<u>WATER JOINTS ON 1½" CU-NI PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-1013-6P</u>	REV. <u>0</u>
	SHEET NO. <u>18</u>	OF <u>22</u>

ANALYSIS CONT'D

SHEAR CONT'D

II. LOCAL MAX. SHEAR

DETERMINE $h \rightarrow K_1 = 4.0; K_2 = -5.88; K_3 = 37.103; K_4 = -4.239$

TORSION:	$h = 7.12$	<u>STRESS</u>
NORMAL $T = 156 \text{ IN-LB}$		2300 psi
UPSET $T = 648 \text{ IN-LB}$		9552 psi
FAULTED $T = 576 \text{ IN-LB}$		8491 psi

TOTAL LOCAL SHEAR 3A+3B (SECTIONS) WORST CASE

$\sigma_{V_L} = 593 + 9552$ (NO HOOP STRESS ON OPEN SECTION)

$\sigma_{V_L} = 10145 \text{ psi} < 10400 \text{ psi}$ \therefore ACCEPTABLE

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>J.V.D.</u>	DATE <u>10-24-88</u>
<u>WATER JOINTS ON 1 1/2" CU-NL PIPING</u>	CHKD. BY <u>JLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-1013 GP</u>	REV. <u>0</u>
	SHEET NO. <u>19</u>	OF <u>22</u>

PRESSURE BOUNDARY

AT PRESENT, THROUGH WALL HOLES EXIST AT SEVERAL JOINTS (SEE TABLE 1) THESE HOLES ARE OF UNDETERMINED SIZE. THIS CALCULATION QUALIFIES THE PIPING FOR A 3/4" HOLE DIAMETER.

TO INSURE THAT SUFFICIENT METAL AREA EXISTS IN THE ZONE SURROUNDING THE HOLE TO PROVIDE ADEQUATE PRESSURE REINFORCEMENT, THE FOLLOWING IS SHOWN:

REINFORCEMENT AREA REQUIRED $A_R = 1.07(t_{mh})(d_1)$ REF. 1a

REINFORCEMENT AREA AVAILABLE $A_A = A_1 = d_2 [T_h - t_{mh}]$ REF. 1a

WHERE $d_1 = \text{I.D. OF BRANCH (HOLE)} = 3/4"$ (BOUNDING)

$$t_{mh} = \text{MIN. WALL OF PIPE} = \frac{PD_o}{2(SE + P_y)} + A$$

P = DESIGN PRESSURE = 100 psi

$D_o = 1.9"$

S = 8700 psi

Y = .4

A = 0 NO CORROSION ALLOWANCE

E = 1.0

$t_{mh} = .011"$ (MIN. WALL)

$T_h = \text{NOMINAL PIPE THICKNESS} = .10"$ (BOUNDING)

$d_2 = d_1 = 3/4"$ COMPARING CODE CHOICES

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT EVALUATION OF ERODED SERVICE BY S.V.D. DATE 10-24-88
WATER JOINTS ON 1½" CU-NI PIPING CHKD. BY DLC DATE 11-18-88
MP3 CALC. NO. 85-127-101.36P REV. 0
 SHEET NO. 20 OF 22

PRESSURE BOUNDARY CONT'D

$$A_R = 1.07(.011)(.75) = .009 \text{ in}^2$$

$$A_A = .75[.10 - .011] = .067 \text{ in}^2$$

SINCE $A_A = .067 \text{ in}^2 > .009 \text{ in}^2 = A_R$ ∴ ACCEPTABLE PRESSURE REINFORCEMENT

LOCAL BUCKLING

SECTION IS FULLY EFFECTIVE WHEN $\frac{t_m}{D_o} < \frac{3300}{F_y}$ (REF. 5 SEC. 1.9.2.3)

$$\frac{.10}{1.9} = .053 < .25 = \frac{3300}{13000}$$

$$F_y = S_y = 13000 \text{ psi}$$

∴ ACCEPTABLE

BRITTLE FRACTURE

BRITTLE FRACTURE IS NOT A CONCERN FOR NON-FERROUS MATERIALS WHICH ARE DUCTILE AND FULLY EXCEED CHARPY IMPACT LIMITS

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>A.V.D.</u>	DATE <u>10-24-88</u>
<u>WATER JOINTS ON 1½" Cu-Ni PIPING</u>	CHKD. BY <u>DLC</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-1013-GP</u>	REV. <u>0</u>
	SHEET NO. <u>21</u>	OF <u>22</u>

SUMMARY

THE ERODED PIPING SECTIONS TABULATED IN TABLE 1 (PG.3) HAVE BEEN EVALUATED AND QUALIFIED FOR ALL PRIMARY LOADS THEY ARE SUBJECT TO. BY MEETING ASME CODE (REF.1) ALLOWABLES FOR AVERAGE X-SECTION STRESSES, THE PIPE SECTIONS HAVE BEEN SHOWN TO MAINTAIN STRUCTURAL INTEGRITY FOR BOTH SUSTAINED (DEADLOAD, PRESSURE) AND OCCASIONAL (EARTHQUAKE) LOADS. LOCAL BUCKLING OF THE ERODED AREA AND PRESSURE REINFORCEMENT REQUIREMENTS HAVE ALSO BEEN SHOWN ACCEPTABLE. PIPING MINIMUM WALL REQUIREMENTS FOR PRESSURE BOUNDARY INTEGRITY ARE QUALIFIED. BRITTLE FRACTURE OF THE OPEN SECTION HAS BEEN SHOWN NOT TO BE A CONCERN. LOCAL STRESSES IN THE ZONE OF THE EROSION HAVE BEEN QUALIFIED FOR STRUCTURAL INTEGRITY ALSO.

CONCLUSION

THE ERODED SECTIONS OF 1½" Cu-Ni PIPING AT MP3 AS LISTED IN TABLE 1 (PG.3) HAVE BEEN QUALIFIED FOR THE FOLLOWING BOUNDING CONDITIONS.

1. MAXIMUM HOLE SIZE = $\frac{3}{4}$ "
2. MINIMUM WALL THICKNESS = .10" AT ANY POINT OUTSIDE THE PROJECTED HOLE SIZE SPECIFIED IN #1 ABOVE

THESE CONDITIONS MUST BE MET FOR THE SERVICE WATER SYSTEM TO REMAIN QUALIFIED TO SUPPORT CONTINUED PLANT OPERATION. ANY ERODED JOINT NOT MEETING THE ABOVE CRITERIA WILL REQUIRE RE-EVALUATION

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT <u>EVALUATION OF ERODED SERVICE</u>	BY <u>A.V.D.</u>	DATE <u>10-24-88</u>
<u>WATER JOINTS ON 1½" CU-NI PIPING</u>	CHKD. BY <u>DLG</u>	DATE <u>11-18-88</u>
<u>MP3</u>	CALC. NO. <u>85-127-1013-GP</u>	REV. <u>0</u>
	SHEET NO. <u>22</u>	OF <u>22</u>

CONCLUSION CONT'D

THE PIPING IN THIS CONDITION HAS BEEN SHOWN TO MEET ALL DESIGN CRITERIA AND ASME CODE ALLOWABLES SPECIFIED IN THE ORIGINAL MP3 PLANT DESIGN REQUIREMENTS

THEREFORE, THE NCR'S ADDRESSING THE 1½" PIPING EROSION (TABLE 1) MAY BE DISPOSITIONED "USE-AS-IS" SO LONG AS EROSION CAN BE DEMONSTRATED TO MEET THE LIMITS SPECIFIED ON PG.

NORTHEAST UTILITIES SERVICE COMPANY

SUBJECT _____ BY _____ DATE _____
CHKD. BY _____ DATE _____
CALC. NO. 85-127-1013 GP REV. 0
SHEET NO. A1 OF _____

ATTACHMENTS

ATTACHMENT 1

PG. A2
* FROM R018

CALC	P.T.	UNLOAD			OFFT			DEFL			SSET			SSEA		
		Mx	My	Mz	Mx	My	Mz	Mx	My	Mz	Mx	My	Mz	Mx	My	Mz
621-X0 R2049008 3056 10/23/84	35 152 156 247 260 330 350	0 0 0 4 13 0 0	0 6 7 2 4 1 0	0 0 0 8 8 10 0	4 6 6 5 6 0 1	1 5 5 2 5 2 0	5 5 6 6 11 4 1	0 0 0 1 0 0 0	5 9 9 7 9 1 1	2 7 8 3 7 2 1	6 7 9 8 15 6 1					
622-X0 R2049305 3052440 3/29/84	1102 1115 1120 1122	0 0 0 0	0 0 0 0	4 6 1 1	4 4 13 12	5 11 4 1	5 6 17 14	0 0 0 0	5 6 17 14	6 19 18 1	7 17 7 54					
627-X0 R2049005 3052661 8/1/84	780 1220	2 0	0 0	9 1	39 0	8 1	18 1	0 0	33 0	12 1	20 1	0 0	0 0			
687-X0 R2049009 3052802 8/2/84	75 90 95 204 257	0 0 0 1 0	0 0 0 5 8	5 1 5 1 1	1 1 13 2 10	2 13 1 23 5	3 3 3 7 5	0 0 0 0 0	1 1 18 3 14	1 17 1 31 7	4 5 4 10 7					
923-X0 R2049017 3051225 6-20-84	140 155	2 8	0 1	7 3	4 7	2 3	8 5	2 1	5 8	2 4	9 6	2 1	2 1			

ATTACHMENT 1

CARC	PT.	DEADLOAD			OBEI			OBEA			SSEI			SSEA		
		F _x	F _y	F _z	F _x	F _y	F _z	F _x	F _y	F _z	F _x	F _y	F _z	F _x	F _y	F _z
621-XD	35	4	12	1	13	5	9	0	0	0	17	7	12			
	152	13	1	2	7	9	5	1	0	0	9	13	8			
	156	12	1	2	6	9	5	1	0	0	9	12	7			
	247	11	3	2	14	10	15	1	1	0	20	14	21			
	260	3	24	4	11	13	4	0	1	0	15	19	5			
	330	8	10	0	2	6	1	3	1	0	3	8	2			
350	4	8	0	3	3	4	0	3	0	5	4	5				
622-XA	1102	2	58	0	9	27	4	0	2	0	12	39	6			
	1115	19	1	0	13	18	15	2	0	0	20	27	21			
	1120	1	7	0	5	3	17	0	0	0	8	23	23			
	1122	21	0	11	4	22	3	0	0	0	5	30	4			
627-XD	780	2	43	1	14	68	32	0	1	0	14	60	28	0	1	0
	1220	1	9	0	1	1	1	0	0	0	1	1	1	0	0	0
687-XD	75	3	25	0	4	7	2	0	0	0	5	11	3			
	90	3	9	0	7	2	3	0	0	0	9	3	4			
	95	10	3	0	3	3	9	0	0	0	5	5	12			
	204	3	3	11	9	6	21	0	0	0	14	8	28			
	257	25	4	1	22	11	10	1	0	0	28	15	15			
	923-XA	140	6	40	5	27	8	2	1	9	7	30	11	2	0	3*
155	6	6	26	9	7	10	4	2	4	15	8	12	3	2	6*	

ATTACHMENT 2

rev. 10/13/88

Service Water Piping with
known Degredation

Line No.	FW No.	ISO Drawing No.	Location	NCR	Comments
3-SWP-150-103-03	FW4	CP319732	CCE-A, IN	3-88-139	923 <u>PT. 140</u>
3-SWP-150-104-03	FW1	CP319732	CCE-A, ^{IN} OUT	3-88-138	923 PT. 155
3-SWP-150-103-03	FW4-	CP319715	CCE-A, IN	3-88-109	EVALUATED PREVIOUSLY
3-SWP-150-103-03	FW3-1	CP319715	CCE-A, IN	3-88 109	EVALUATED PREVIOUSLY
3-SWP-150-061-03	FW2	CP319030	CCI-B, IN	3-88-108	622 PT. 1122
3-SWP-150-061-03	FW4	CP319030	CCI-B, IN	3-88-108	622 PT. 1120
3-SWP-150-061-03	FW2-1	CP319011	CCI-B, IN	3-88-108	622 PT. 1115
3-SWP-150-061-03	FW4	CP319011	CCI-B, IN	3-88-107	622 PT. 1112
3-SWP-150-064-03	FW19	CP319009	CCI-B, OUT	3-88-106	621 PT. 247
3-SWP-150-064-03	FW9	CP319031	CCI-B, OUT	3-87-054	621 PT. 260
3-SWP-150-064-03	FW13	CP319031	CCI-B, OUT	3-87-054	621 PT. 330
3-SWP-150-071-03	FW1-1	CP319033	CCI-A, IN	3-88-105	627 PT. 1220
3-SWP-150-071-03	FW6	CP319010	CCI-A, IN	3-87-054	621 PT. 780
3-SWP-150-072-03	FW52	CP319008	CCI-A, OUT	3-88-104	687 PT. 204
3-SWP-150-064-03	FW4	CP319009	CCI-B, OUT	3-88-116	EVALUATED PREVIOUSLY
3-SWP-150-072-03	FW6	CP319008	CCI-A, OUT	3-88-113	687 PT. 257 clamp
3-SWP-150-072-03	FW6	CP319032	CCI-A, OUT	3-88-111	687 PT. 95 wrapped REMOVE FROM LIST
3-SWP-150-072-03	FW1	CP319032	CCI-A, OUT	3-88-111	687 PT. 90 wrapped REPAIRED
3-SWP-150-064-03	FW5, 7	CP319009	CCI-B, OUT	3-88-112	621 <u>PTS 152, 156</u> REPAIRED
3-SWP-150-064-03	FW4	CP319031	CCI-B, OUT	3-87-054	621 PT. 350 leaker
3-SWP-008-049-03			HVK-B	3-88-097	throttling
3-SWP-018-310-03			CCS	3-88-101	problems
3-SWP-002-384-03	FW3-1	CP319767	HVQ-1A	3-88-099	clad problem
3-SWP-002-384-03	FW5	CP319767	HVQ-1A	3-88-131	.221wall

NORTHEAST UTILITIES



THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
NEW YORK WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

July 25, 1988
PSE-CE-88-463

TO: Mr. S. V. Dumas
Berlin, W21

FROM: *R. Y. Schonenberg*
R. Y. Schonenberg
Component Engineering
Berlin, W21 (Ext. 5364)

SUBJECT: MILLSTONE UNIT NO. 3
SERVICE WATER PIPING TO CCE AND CCI HEAT EXCHANGERS

REFERENCES: 1) Crisp #1303940, T. E. Davis to R. Y. Schonenberg, 07/15/88.
2) Crisp #1303393, R. C. Wittmer to R. Y. Schonenberg, 10/13/87.
3) Crisp #1302954, R. C. Wittmer to R. Y. Schonenberg, 04/02/87.

Based upon the UT data in Reference 1, all the joints listed in Table 1 need to be evaluated for their structural acceptability. Where possible, the anticipated rate of wall loss is also listed. This rate is based upon an evaluation of the ECT data in References 2 and 3, and that currently being gathered. Comparative data was not available in all cases to calculate a rate of wall loss. If more UT data is needed, contact T. Davis. Where possible, it is requested that the joints be grouped into three categories:

- 1) Seismically acceptable now and expected to remain that way until the next refueling outage in 1989.
2. Seismically acceptable now but expected to become unacceptable before the next refue. outage in 1989.
3. Seismically acceptable now.

Another list of joints will be generated as soon as the piping to and from the HVQ and HVR heat exchangers is examined. It is requested that the analysis for the joints in Table 1 be completed by 09/15/88.

RYS/beb
Attachment

CC: PSE *gk*
T. J. Mawson
B. W. Nichols (MP3)

ATTACHMENT 3

Attachment to PSE-CE-88-463

TABLE 1

CCE and CCI Piping Joints with Wall Loss

<u>Line No.</u>	<u>Weld Number</u>	<u>ISO Drawing Number</u>	<u>Current Wall</u>	<u>Rate of Wall Loss</u>
3-SWP-150-103-03	FW4-1	CP319715	.150	N/A
3-SWP-150-103-03	FW3-1	CP319715	.098	N/A
3-SWP-150-061-03	FW2	CP319030	.096	.0005"/month
3-SWP-150-061-03	FW4	CP319030	.090	.0005"/month
3-SWP-150-061-03	FW2-1	CP319011	.114	.0005"/month
3-SWP-150-061-03	FW4	CP319011	.048	.008"/month
3-SWP-150-064-03	FW19	CP319009	.090	.002"/month
3-SWP-150-064-03	FW9	CP319031	.060	.003"/month
3-SWP-150-064-03	FW13	CP319031	.034	.002"/month
3-SWP-150-071-03	FW1-1	CP319033	.130	.004"/month
3-SWP-150-071-03	FW6	CP319010	.065	N/A
3-SWP-150-071-03	FW52	CP319008	.104	N/A

RYS/bab
07/25/88

NORTHEAST UTILITIES



THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
MILSTONE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

ATTACHMENT 3

P6 A7

M
E
M
O

To: R. Y. Schonenberg
Generation Mechanical Engineering

July 15, 1988
Crisp#1303940

From: T. E. Davis
NUSCO NTE

T.E.D.-1

Subject: Ultrasonic Thickness Measurement on MP3 Service
Water per Memo # PSE-CE-88-411

In response to your memo dated 6-23-88, an Ultrasonic Thickness measurement was performed on the 1 1/2" brazed joints that you selected. The results of the examinations are shown on the attached data sheet with a tolerance of + or - .005". The clock locations of the readings are in the clockwise direction looking downstream (direction of flow). If there are any questions regarding these examination results please contact me at Millstone extension 4071 or contact C. M. Peterson in Rocky Hill at extension 4665.

cc: C.M. Peterson
D.R. MacNeill
B.W. Nichols
S.V. Dumas
R.C. Wittmer
NDE File # 88-024

ATTACHMENT 3

ATTACHMENT 1

WELD #	BLD	UT READING	ECT READING	CLOCK LOCATION
FW4-1	AUX	.150	70%	11 TO 1
FW3-1	AUX	.098	25%	11 TO 1
FW7	AUX	.145	0%	360 DEG
FW8	AUX	.145	0%	360 DEG
FW3	AUX	.145	0%	360 DEG
FW4	AUX	.145	0%	360 DEG
FW3	AUX	.145	0%	360 DEG
FW4	AUX	.145	0%	360 DEG
FW2	ESF	.096	0%	11 TO 12
FW4	ESF	.090	30%	12 TO 3
FW2-1	ESF	.114	30%	12 TO 1
FW4	ESF	.048	80%	12 TO 3
FW6	ESF	.147	0%	360 DEG
FW10	ESF	.137	0%	360 DEG
FW12	ESF	.140	0%	360 DEG
FW13	ESF	.147	0%	360 DEG
FW4	ESF	.140	50%	360 DEG
FW19	ESF	.090	>25%	6 TO 7
FW9	ESF	.060	80%	11 TO 1
FW13	ESF	.034	60%	4 TO 5
FW1-1	ESF	.130	80%	12
FW6	ESF	.065	60%	10 TO 1
FW52	ESF	.104	40%	3 TO 4

NOTE: ECT DATA IS WRITTEN IN % OF WALL LOSS

ATTACHMENT 3

F6A9

Clock Position	Line Number				Weld Number			
	3-SWP-150-103-03				FW2			
	Distance from weld(inches)							
	AOT	1"	2"	3"	V31			
1	.141	.145	.146	.141				
2	.127	.139	.137	.141				
3	.072	.142	.145	.142				
4	.076	.129	.142	.140				
5	.140	.139	.139	.143				
6	.145	.146	.147	.142				
7	.148	.144	.150	.149				
8	.148	.148	.147	.148				
9	.146	.148	.146	.142				
10	.145	.145	.152	.140				
11	.150	.143	.156	.137				
12	.147	.151	.148	.136	V			

	Line Number				Weld Number			
	3-SWA-150-103-03				FW4			
1	.151	.151	.151	.151				
2	.151	.148	.151	.152				
3	.152	.149	.149	.151				
4	.143	.137	.138	.147				
5	.127	.100	.121	.136				
6	.096 .103	.097 .110	.120	.136	.149			
7	.141	.131	.142	.141				
8	.147	.145	.145	.146				
9	.147	.153	.151	.144				
10	.151	.143	.139	.144				
11	.146	.147	.147	.148				
12	.151	.149	.149	.148				

CALCULATION CHECKLIST

1. <u>Preparation</u>	<u>Section</u>	<u>Preparer's Initial</u>
1.1 Legible, reproducible, comprehensive	6.1.1	<u>AVD</u>
1.2 ID Logged in, retrievable	6.1.2	<u>AVD</u>
1.3 Documentation format and contents complete	6.1.3	<u>AVD</u>
1.4 As-built information added	6.1.4	<u>AVD</u>
2. <u>Verification</u>	<u>Section</u>	<u>I.R. Initials</u>
2.1 Documentation complete	6.2.1	<u>DC</u>
2.2 Prepared in accordance with Section 6.1	6.2.2.1	<u>DC</u>
2.3 Assumptions reasonable	6.2.2.2	<u>DC</u>
2.4 Method acceptable	6.2.2.3	<u>DC</u>
2.5 Input data correct	6.2.2.4	<u>DC</u>
2.6 Modeling adequate	6.2.2.5	<u>DC</u>
2.7 Manual calculations correct	6.2.2.6	<u>DC</u>
2.8 Computer calculations correct	6.2.2.7	<u>N/A</u>
2.9 Design requirements met	6.2.2.8	<u>DC</u>
2.10 Solution correct	6.2.2.9	<u>DC</u>
2.11 Software validated	6.2.2.10	<u>N/A</u>
2.13 Review method identified	6.2.2.11	<u>DC</u>

3. Comment Resolution

<u>Comments</u>	<u>Disposition</u>	<u>I.R. Initials</u>
<u>N/A</u>		