PSEG

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Nuclear Business Unit

FEB 2 8 2000

LR-N00066

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Gentlemen:

CHEMICAL AND VOLUME CONTROL TANK INDICATIONS
SALEM NUCLEAR GENERATING STATION UNIT 1
DOCKET NO. 50-272

In accordance with NRC Inspection Manual, Part 9900, guidance concerning ASME Boiler and Pressure Vessel Code, Sections III and XI, Public Service Electric and Gas (PSE&G) is providing the following information concerning two flaws that were discovered in the Chemical and Volume Control Tank "shell to lower head girth weld" during the scheduled UT weld exam that took place in the Salem Unit 1,13th Refueling Outage (1R13). The circumstances involving the flaw identification were originally discussed with the NRR Project Manager during teleconferences held in October 1999.

The two flaws are in the "shell to lower head girth weld" on the Chemical and Volume Control Tank (1CVE6). One flaw was measured at 0.2" long with a through wall dimension of 0.08". The other flaw was measured at 0.7" in length with a through wall dimension of 0.12". These flaws are mid-plane and do not originate or terminate at the tank walls. These flaws were determined to be in excess of that allowed by IWC-2500 Examination Category C-A of Section XI. IWC-3000 has no specific acceptance standards for flaws, but permits the use of Class 1 acceptance criteria found in IWB-3000. IWB-3122.4 alternatively permits acceptance by an analytical method. PSE&G has elected this approach, using Structural Integrity Associates (SIA) services to perform the Code required analysis. Based on the SIA analysis, PSEG determined that the VCT could be dispositioned as "USE-AS-IS." The SIA evaluation is enclosed for your review.

The evaluation considered dimension and orientation of the flaws, loads (inclusive of seismic), period of service, and all possible crack growth mechanisms. The findings of the SIA evaluation are summarized as follows:

A047

- The allowable defect sizes are very large compared to that observed. Assuming a 360° circumferential flaw, the allowable flaw depth-to-thickness (a/t) ratio is 65%. For a through-wall flaw, up to 41.3% of the circumference can be tolerated without violating ASME Section XI Safety margins. This compares to the two identified subsurface flaws length of 0.2 in. and 0.7 in. (<0.4% of circumference) and depths (2a) of 22.8% and 41.36% respectively.

- Fatigue crack growth evaluation assuming 1000 pressurization cycles resulted in insignificant crack growth (approximately 1.1×10^{-5} inch) indicating that crack extension during operation will not occur.

- Since the flaws are subsurface and therefore not in contact with the environment, there are no active crack growth mechanisms other than fatigue that could cause the flaws to grow during service.

A. Root Cause

The indications recorded are believed to be from the welding fabrication process. This conclusion was reached after ultrasonic analysis revealed no "ID" or "OD" connection. In addition, the defect plots have the flaw lying at the same angle as the weld prep.

The fatigue crack growth evaluation, based on an assumed 1000 pressurization cycles, demonstrated an insignificant crack growth of approximately 1.1 x 10-5 inch. This supports our position that crack extension during operation will not occur.

B. Flaw Evaluation

The net section plastic collapse approach in IWB-3640, supplemented by Appendix C of ASME Section XI, was used to determine the allowable flaw sizes for the VCT tank 1CVE6, at Salem Unit 1. The reasons for this evaluation approach are as follows.

1) The VCT tank, 1CVE6, is fabricated from Type 304 stainless steel. The tank is classified as a Class 2 tank. Currently, there are no flaw evaluation methods for Class 2 components in ASME Section XI and therefore Class 1 rules in IWB-3600 are generally used for Class 2 components. In IWB-3600, there are no specific rules for stainless steel tanks.

2) Because of their inherent ductility and toughness, the net section plastic collapse methodology is used for the failure criteria for stainless steel components. Therefore, this methodology was chosen to determine the allowable flaw size for the tank. Though there are no specific rules for

stainless steel tanks in IWB-3600, rules are available for stainless steel piping components in IWB-3640. These are based on the net section plastic collapse. Appendix C of ASME Section XI provides the net section plastic collapse equations for stainless steel pipes subjected to the primary membrane and bending stresses. These same equations are directly applicable to stainless steel tanks, since they are also cylindrical thin wall components.

In the evaluation, a conservative assumption was made that the welding of the shell to lower head was performed using a fluxed welding process. In order to account for the relatively low toughness of the fluxed welds, the most conservative Z factor in IWB-3640 and Appendix C of ASME Section XI was used in the net section.

C. Flaw Sizing Uncertainty

A study that would establish the flaw sizing uncertainty for manual UT sizing of welding defects not connected to either weld surface has not been performed. Therefore, steps were taken to ensure that the recorded data was accurate. These steps included an independent evaluation of the initial examination and confirmation on all recorded parameters.

Because it is understood by the code that ultrasonic flaw sizing is limited with regard to precisely defining the actual dimensions or area of the detected indication a flaw-circumscribing rule was adopted. This rule requires that the extremities of an irregular indication be enveloped by a square or rectangular area within which ellipses or circles are inscribed as representative of flaw geometry. Although the actual flaws may not totally fill the square or rectangle boundary the envelope of the square or rectangle is always conservative, particularly in the case of very small flaws. In addition, conservatism was built in to the flaws analytical evaluation.

The technique used was the amplitude drop method. While this method has been shown to be limited when sizing crack type flaws (such as IGSCC), the ASME code recognizes it as an acceptable sizing method. In addition, an "ID" creeping wave was used to confirm the lack of "ID" connection.

D. Conclusion

Based on the above, PSE&G has concluded that the CVC tank 1CVE6 at Salem Unit 1 meets the safety margin of ASME Section XI for continued operation with the flaws identified during 1R13 remaining in place. PSE&G will perform successive examinations as required by IWB-2420 until the repairs are performed.

Should you have any further questions regarding this report, please contact Robin Ritzman at (856) 339-1445.

Sincerely,

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RAR

BC (without attachment)

Vice President - Operations (X10)
Vice President – Maintenance (X10)
Vice President – Technical Support (X10)
Director - QA (X01)
Licensing Manager (N21)
Manager - Financial Planning and Cost Control (N07)
Program Manager - Nuclear Review Board (N38)
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NGC-99-032

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Subject: Evaluation of Flaws in the Shell to Lower Head Weld of Chemical and Volume Control Tank (1CVE6) at Salem Unit 1

Dear Tom:

This letter summarizes the results of analyses performed to evaluate the flaws identified in the shell to lower head weld of the chemical and volume control tank 1CVE6 at Salem Unit 1 during 1999 outage (U1-RFO-13). Two separate analyses were performed. In the first analysis, a finite element stress analysis was performed to determine the stresses in the tank near the flaw locations. The calculated stresses were then used in a second analysis to determine the allowable flaw size. Guidance was taken from IWB-3640 and Appendix C of ASME Code Section XI to perform the analysis.

STRESS ANALYSIS

The stress analysis of the tank was performed using an axisymmetric finite element model. The maximum operating temperature of the tank is relatively low (127°F) and as such no significant thermal stresses are expected. Therefore, only pressure related loadings were considered in the analysis. The maximum operating pressure of 60 psi was imposed on the model to determine the pressure stresses in the vicinity of the flaw.

The results of the internal operating pressure analysis indicated that the maximum axial membrane stress in the cylindrical portion of the tank remote from the shell to head intersection is 4.64 ksi with insignificant through-wall bending stress. At the head to shell intersection, the axial membrane stress is 4.52 ksi with a through-wall bending stress of 3.99 ksi.

In addition to the operating pressure, there is a maximum hydrostatic pressure of 4.5 psi at the bottom of the tank assuming the tank is completely full. There is also a maximum DBE vertical seismic loading of 3.16 g associated with the peak of the response spectrum for this location. This will increase the hydrostatic pressure by a factor of 4.16 during a seismic event resulting in a total hydrostatic pressure of 18.72 psi. Hence the pressure stresses determined above are factored by 1.312. Though not specifically analyzed, it was conservatively assumed in the subsequent crack growth evaluation that there is yield level through-wall bending residual stress present in the weld.

The effect of horizontal seismic loads at this location are not significant since the tank legs are above the lower head shell weld and are remote from the flaw location.

Details of the stress analysis are presented in the attached SI Calculation PSEG-07Q-301, Rev. 0.

FLAW EVALUATION

The flaw evaluation consisted of two parts. In the first part, the allowable flaw sizes per ASME Section XI were determined and compared to the identified flaws to determine the suitability for continued operation. The CVC tank is fabricated from Type 304 stainless steel. Since there are no Section XI flaw evaluation methods for Class 2 stainless steel tanks, the net section plastic collapse methodology which formed the basis for determination of allowable sizes in ASME Section XI for austenitic stainless steel piping was used as guidance for the flaw evaluation of the CVC tank. In determining the allowable flaw size in the CVC tank, two conservative analysis were performed. In the first analysis, a 360° flaw was assumed and the allowable flaw depth was determined. In the second analysis, a through-wall flaw was assumed and the allowable circumferential extent of the flaw was determined. Both analyses were performed with the conservative assumption that the shell to lower head weld is fabricated by fluxed welding which necessitated the use of ASME Section XI Appendix C Z-factors. Since only pressure is involved, a safety factor of 3.0 was used in lieu of 2.77 provided in IWB-3640 and Appendix C of ASME Section XI.

In the second part of the analysis, a fatigue flaw growth analysis was performed to determine if the identified subsurface flaws will grow during service. An elliptical subsurface crack in a plate model similar to that in ASME Section XI was used to determine the stress intensity factor. For the subsurface flaw the ASME Section XI fatigue crack growth law for air environment was then used together with the calculated stress intensity factors to determine the crack growth cycling between the weld residual stress and pressure plus weld residual stress.

Details of the allowable flaw size determination and the crack growth analyses are presented in the attached SI Calculation, PSEG-07Q-302, Rev. 0.

CONCLUSIONS

The following are highlights of the evaluation.

- The allowable flaw sizes are very large compared to that observed. Assuming a 360° circumferential flaw, the allowable flaw depth-to-thickness (a/t) ratio is 65%. For a through-wall flaw, up to 41.3% of the circumference can be tolerated without violating ASME Section XI Safety margins. This compares to the two identified subsurface flaws of length 0.2 in. and 0.7 in. (<0.4% of circumference) and depths (2a) of 22.8% and 41.36% respectively.
- Fatigue crack growth evaluation assuming 1000 pressurization cycles resulted in insignificant crack growth (approximately 1.1×10^{-5} inch) indicating that crack extension during operation will not occur.
- Since the flaws are subsurface and therefore not in contact with the environment, there are no active crack growth mechanisms other than fatigue that could cause the flaws to grow during service.

Based on the above, it is concluded that CVC tank 1CVE6 at Salem Unit 1 meets the safety margins of ASME Section XI for continued operation with the flaws identified in U1-RFO-13 in place.

Structural Integrity Associates appreciates the opportunity to be of service to PSE&G on this evaluation. Please, do not hesitate to call if you have any questions on this letter and attachments or if we can be of further assistance to you on any other plant integrity issues.

Very truly yours,

Prepared and Approved by	Prepared by	Reviewed by
Nathaniel G. Cofie, Ph.D. Associate	Richard L. Bax Engineer	Arthur F. Deardorff Associate

gsv
cc: PSEG-07Q-102/106
PSEG-07Q-401

STRUCTURAL INTEGRITY Associates, Inc.	**CALCULATION PACKAGE**	**FILE No:** PSEG-07Q-301 **PROJECT No:** PSEG-07Q

PROJECT NAME: Salem Unit 1 Chemical and Volume Control Tank (1CVE6) Flaw Evaluation

CLIENT: Public Service Electric and Gas

CALCULATION TITLE: Stress Analysis of Chemical and Volume Control Tank

PROBLEM STATEMENT OR OBJECTIVE OF THE CALCULATION:

Develop a finite element model of the Chemical and Volume Control Tank and determine the stresses resulting from operating conditions.

Document Revision	Affected Pages	Revision Description	Project Mgr. Approval Signature & Date	Preparer(s) & Checker(s) Signatures & Date
0	1 - 12 A0 – A5 Project CD-ROM	Original Issue	[signature] 10/1/99	[signature] RLB 10-11-99 [signature] 10/11/99

1.0 Problem

Cracking has been detected in Chemical and Volume Control Tank (1CVE6) at PSE&G's Salem Unit 1. Develop a finite element model of the control tank such that stresses resulting from operating conditions can be determined. The results will be used in flaw evaluations.

2.0 Design Input

Westinghouse Drawing 110E019 [1] provided the outside dimensions of the control tank. The wall thickness of the tank cylinder and hemispherical heads were based on UT measurements of Tank 1-CVCT-2 [2]. Several additional dimensions were not available and were scaled from drawing 110E019 [1]. The UT evaluation was also used to estimate the weld between the tank cylinder and torus-spherical heads. See Figure 1 for the dimensions used.

Drawing 110E019 [1] also indicated that the control tank was fabricated from ASTM A240 Type 304 stainless steel.

The maximum indicated operating pressure of the control tank is 60 psig [3] and the normal operating temperature is 127°F [3]. No significant thermal transients are expected for this structure.

Piping loads were not included in this evaluation. Examination of drawing 110E019 [1, 2] indicates that the nozzles are significant distance from the flaw indications. Thus piping/nozzle loads will not have an effect on the flaw location.

3.0 Finite Element Model

An axisymmetric model of the control tank was developed using the ANSYS finite element software package [4]. The model included the entire control tank pressure boundary but does not include the tank support legs or the nozzle penetrations. This is considered acceptable since the region of the flaw is some distance from the support legs and nozzles.

The actual welds between the cylinder and hemispherical heads were not directly modeled.

See Figure 2 for the resulting finite element model.

4.0 Mechanical Boundary Conditions

The base of the model (i.e. the bottom outside edge of the lower hemispherical head – See Figure 1) was restrained to motion in the axial direction. The free ends are fixed in the radial direction by ANSYS due to their centerline location in an axisymmetric environment.

5.0 Material Properties

As indicated earlier, the control tank is fabricated with ASTM A240 Type 304 stainless steel. From Reference 3, the operating temperature 127°F. The material properties for this evaluation will be conservatively based on 200°F. The resulting properties are shown below:

Material Property	Value
Modulus of Elasticity, E, psi [5]	27.6e6
Poisson's Ratio (Assumed)	0.3

6.0 Loading

The only load condition evaluated is operating internal pressure.

6.1 Operating Pressure

The maximum operating pressure is 60 psig [3].

For the finite element model, the pressure was applied to all interior surfaces of the tank wall.

See Appendix A for the resulting ANSYS input file, press.inp. It is also included on the Project CD-ROM.

7.0 Results

The results of the pressure analysis and the hydrostatic analysis are discussed below:

7.1 Operating Pressure Results

The resulting stresses due to operating pressure are shown in Figures 4 through 7. To facilitate fracture mechanics evaluations, the linearized through wall stresses were determined for two through wall locations. The locations evaluated are shown in Figure 3. The resulting membrane, bending and membrane plus bending stresses for the two paths are shown in the tables below.

Table 1 – Path 1 Stress Results (See Figure 3)

	Membrane Stresses (psi)									
	SX	SY	SZ	SXY	SYZ	SXZ	S1	S2	S3	SINT
	18.74	4522	6645	-8.552	0	0	6645	4522	18.73	6626
	Bending Stresses (psi)									
Surface	SX	SY	SZ	SXY	SYZ	SXZ	S1	S2	S3	SINT
Inside	41.00	-3990	-1158	218	0	0	52.7	-1158	-4001	4054
Center	0.000	0000	0.000	0.000	0	0	0.000	0.000	0.000	0.000
Outside	-41.00	3990	1158	-218	0	0	4001	1158	52.7	4054
	Membrane Plus Bending Stresses (psi)									
Surface	SX	SY	SZ	SXY	SYZ	SXZ	S1	S2	S3	SINT
Inside	59.74	532.2	5487	208.9	0	0	5487	611.3	-19.41	5507
Center	18.74	4522	6645	-8.552	0	0	6645	4522	18.73	6626
Outside	-22.25	8512	7802	-226	0	0	8518	7802	-28.24	8546

Table 2 - Path 2 Stress Results (See Figure 3)

	Membrane Stresses (psi)									
	SX	SY	SZ	SXY	SYZ	SXZ	S1	S2	S3	SINT
	-29.9	4640	9310	0	0	0	9310	4640	-29.9	9340
	Bending Stresses (psi)									
Surface	SX	SY	SZ	SXY	SYZ	SXZ	S1	S2	S3	SINT
Inside	-29.99	-0.020	29.98	0	0	0	29.98	-0.020	-29.99	59.97
Center	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000	0.000
Outside	29.99	0.020	-29.98	0	0	0	29.99	0.020	-29.98	59.97
	Membrane Plus Bending Stresses (psi)									
Surface	SX	SY	SZ	SXY	SYZ	SXZ	S1	S2	S3	SINT
Inside	-59.89	4640	9340	0	0	0	9340	4640	-59.89	9400
Center	-29.9	4640	9310	0	0	0	9310	4640	-29.9	9340
Outside	0.0832	4640	9280	0	0	0	9280	4640	0.0832	9280

8.0 References

1) PSE&G Drawing No. 106425, Rev. 7, Westinghouse Drawing No. 110E019, "Volume Control Tank," S.I. File PSEG-07Q-202

2) Framatome Technologies UT Data Package No. S1DP137, "Salem Unit 1 (U1-RFO-13), Chemical and Volume Control Tank, 1-CVT-2, Shell to Lower Head," dated 10/8/99, S.I. File PSEG-07Q-201

3) Excerpt from Salem Unit 1 Configuration Baseline Document DE-CB.CVC-0037(Q), Rev. 0, "Table T-8, Component Design Data, Chemical and Volume Control System, Volume Control Tank (1CVE6)," S.I. File PSEG-07Q-203

4) ANSYS LinearPlus/Thermal, Revision 5.3, Second Release, ANSYS Inc., October 1996

5) ASME Boiler and Pressure Vessel Code, Section III, Appendices, 1989 Edition

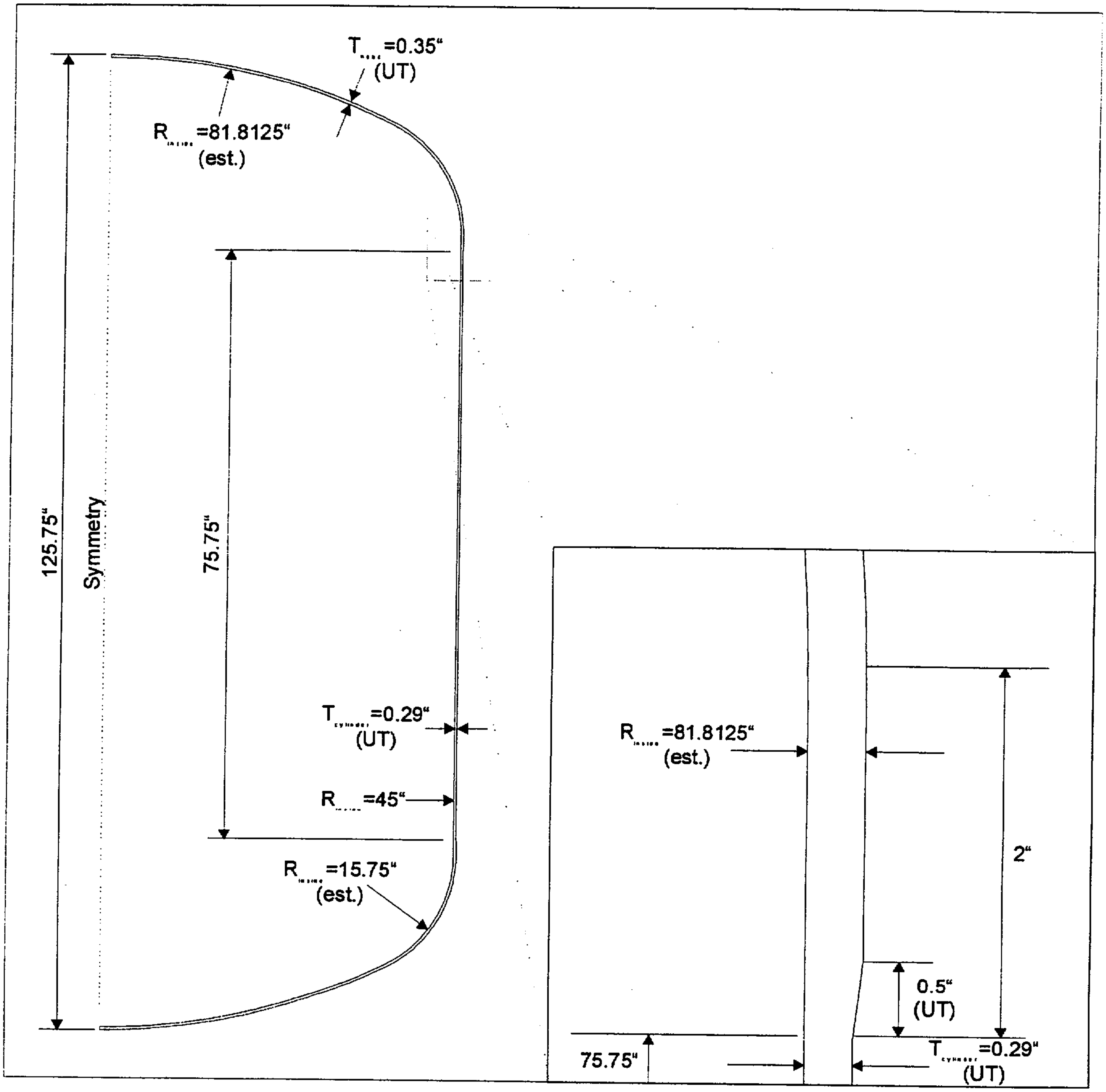

Figure 1 – Dimensions

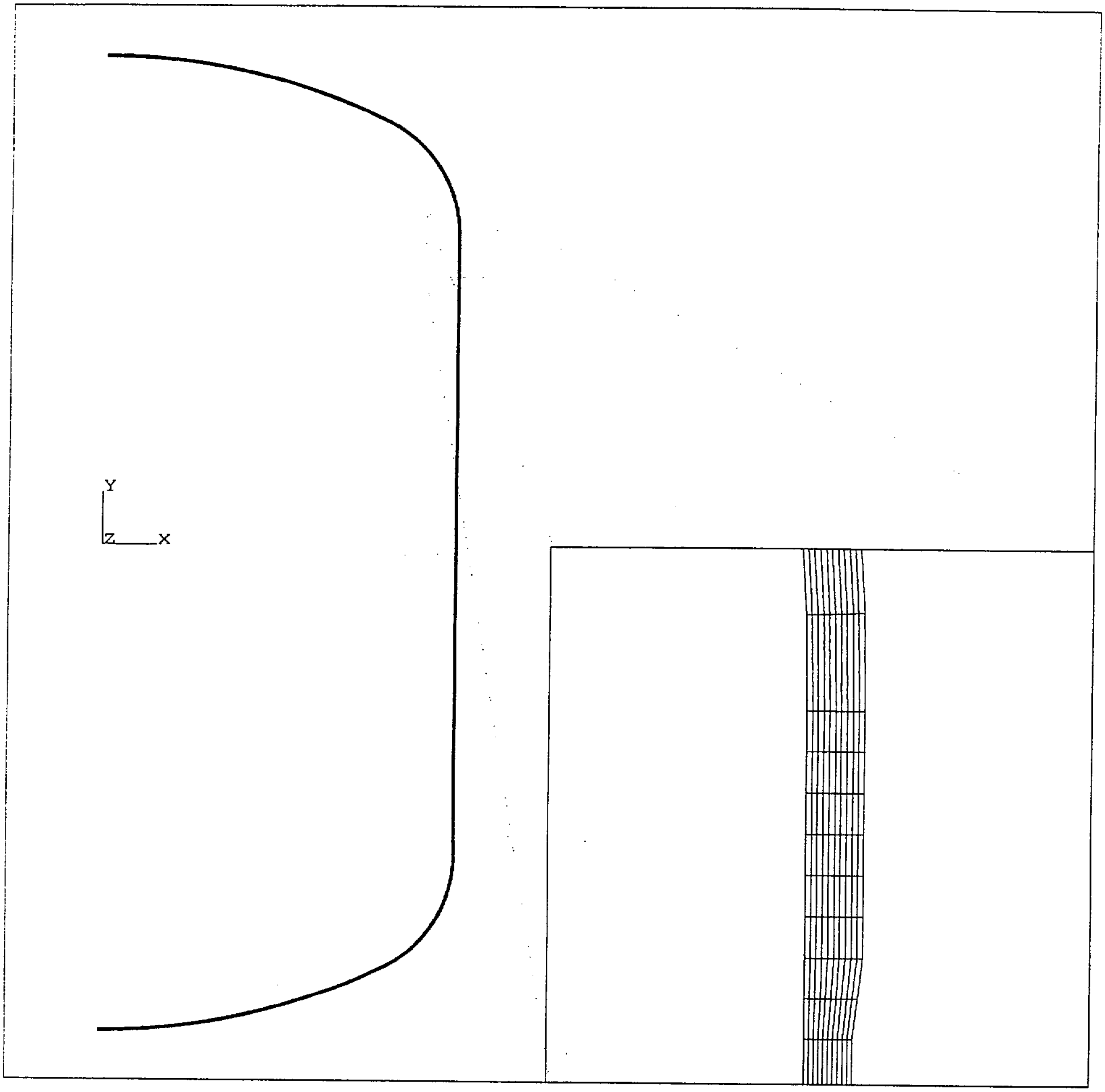

Figure 2 – Finite Element Model

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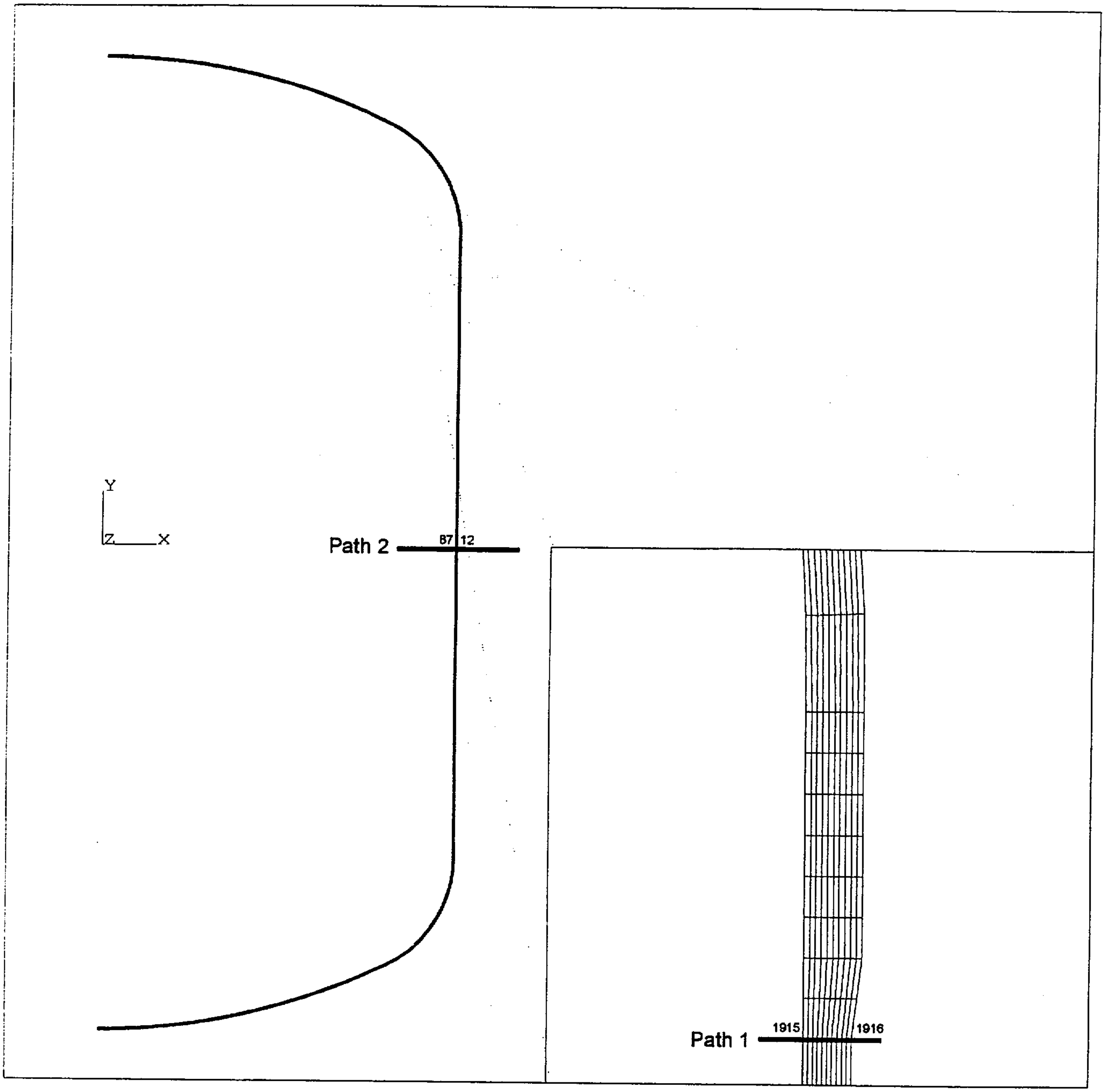

Figure 3 – Linearized Stress Paths

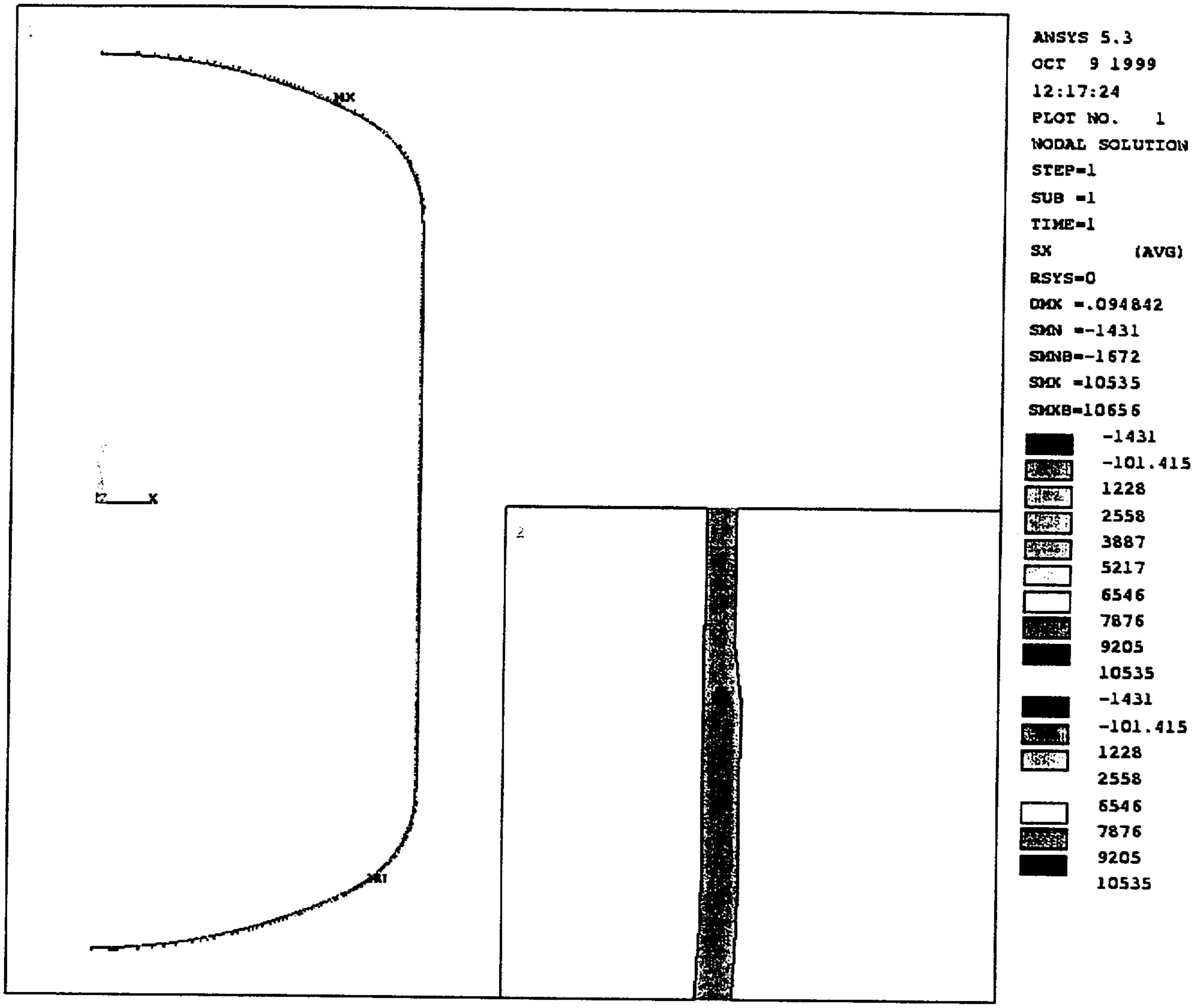

Figure 4 – Radial Stress Due to 60 psig Pressure (Global-X Direction)

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	File No. PSEG-07Q-301			Page 9 of 12	

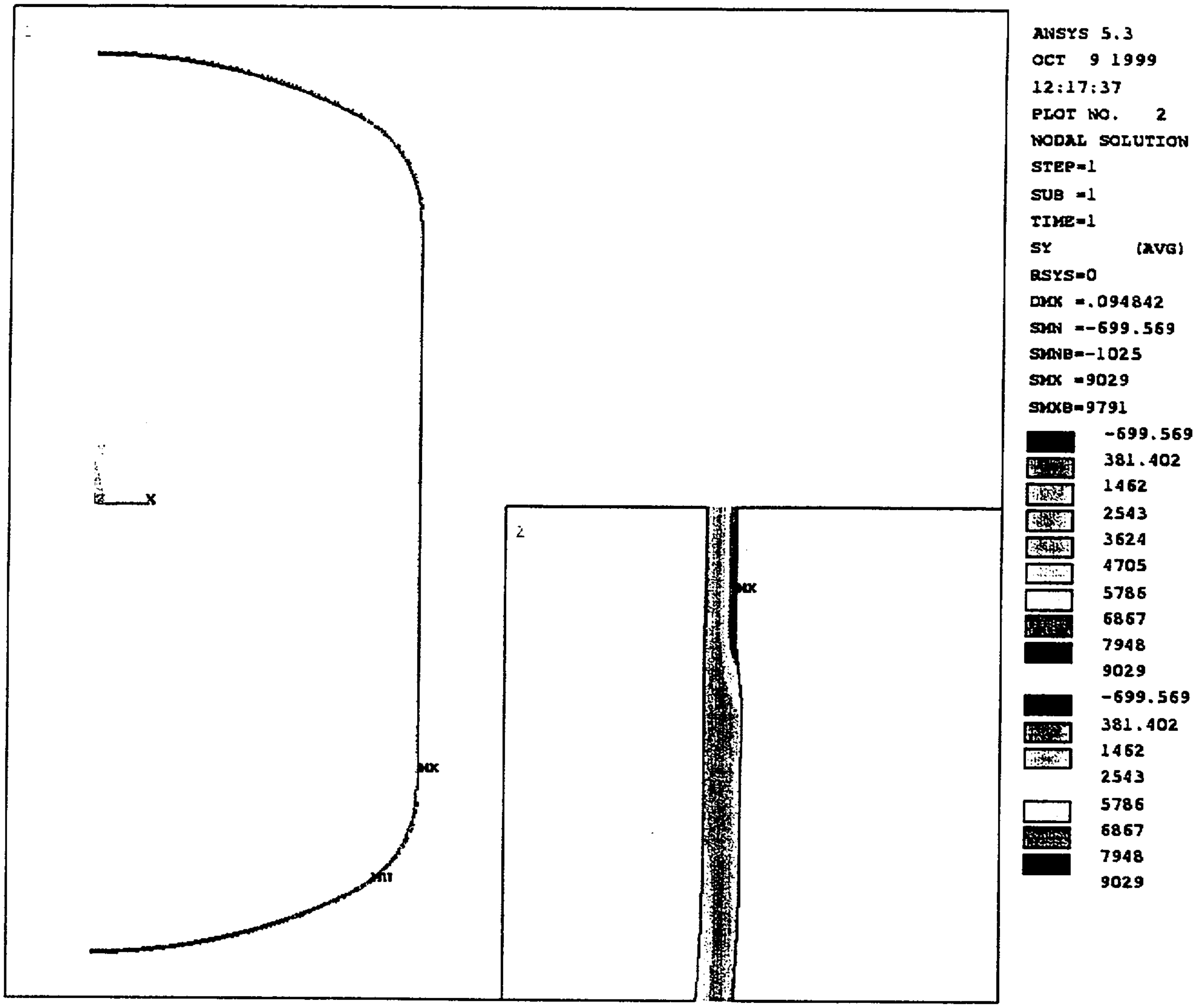

Figure 5 – Axial Stress Due to 60 psig Pressure (Global Y Direction)

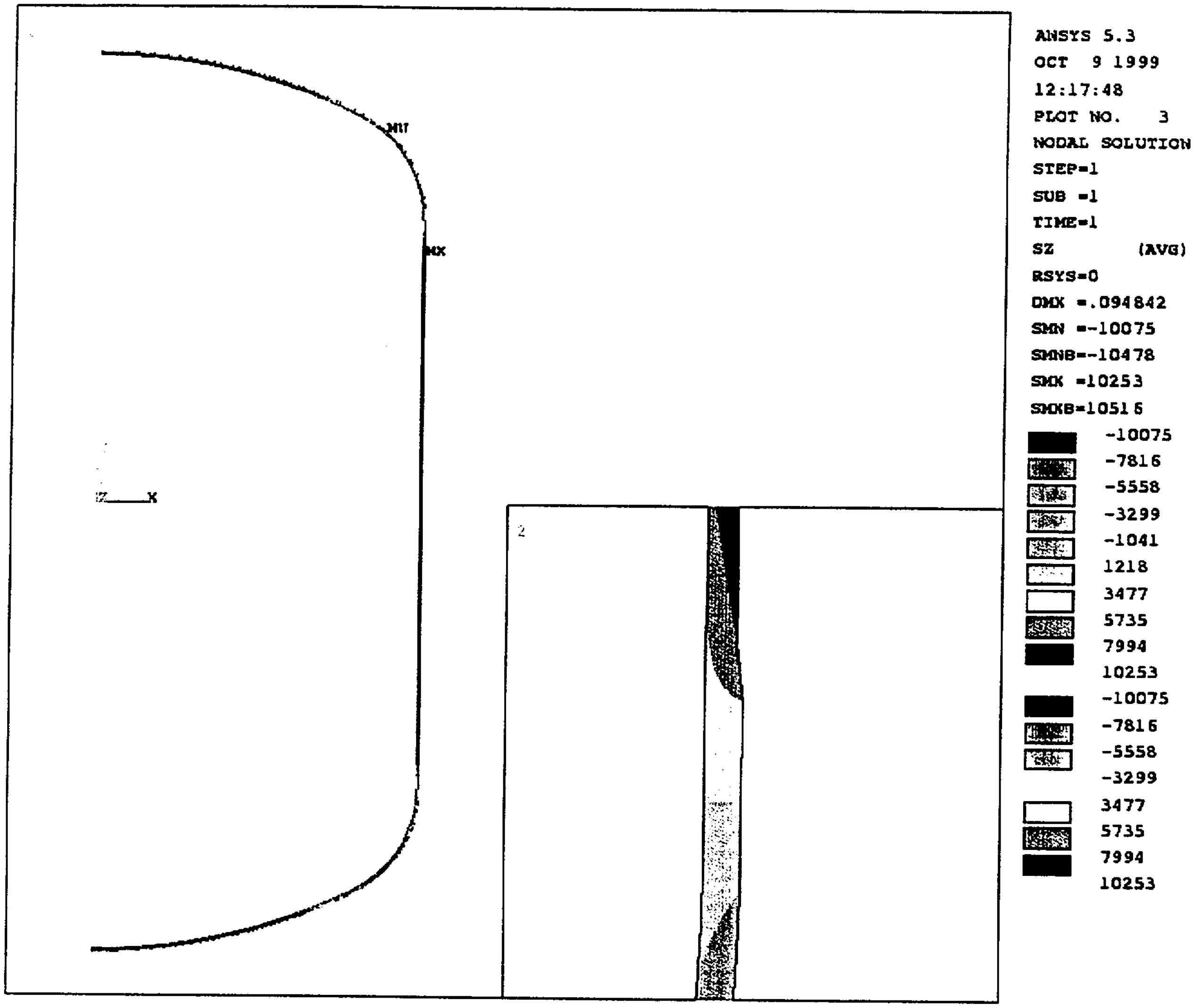

Figure 6 – Hoop Stress Due to 60 psig Pressure (Global-Z Direction)

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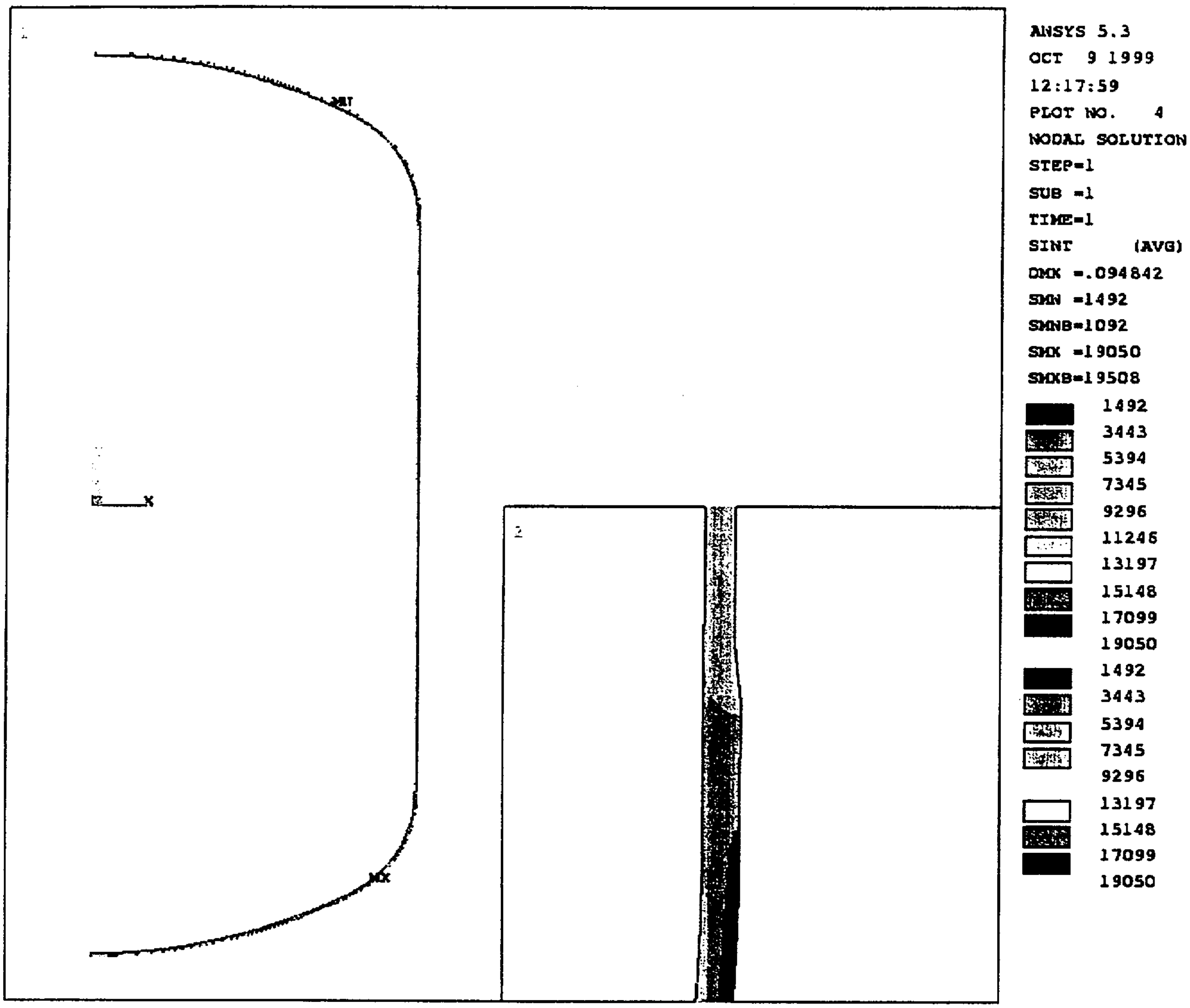

Figure 7 – Stress Intensity Due to 60 psig Pressure

APPENDIX A

ANSYS Input and Result Files

Filename	Description	Page No.
Press.inp	ANSYS Input File	A1 – A3
Press.out	Path 1 Linearized Stress Results (Weld Location)	A4
R-press.out	Path 2 Linearized Stress Results (Remote Location)	A5

```
fini
/CLEAR,START

/PREP7

!*
ET,1,PLANE42
!*
KEYOPT,1,1,0
KEYOPT,1,2,0
KEYOPT,1,3,1
KEYOPT,1,5,0
KEYOPT,1,6,0
!*

/com, Create Geometry

K,1,(90/2)     ,(75.75/2),0
K,2,(90/2)+0.29,(75.75/2),0

K,3,(90/2)     ,0,0
K,4,(90/2)+0.29,0,0

l,1,2,10
l,1,3,75
l,3,4,10
l,4,2,75

a,1,2,4,3

ESHAPE,2,0

/com, Head

K,5,(90/2)     ,(75.75/2)+0.5,0
K,6,(90/2)+0.35,(75.75/2)+0.5,0

l,5,6,10
l,1,5,2
l,2,6,2

a,1,2,6,5

K,7,(90/2)     ,(75.75/2)+2.0,0
K,8,(90/2)+0.35,(75.75/2)+2.0,0

l,7,8,10
l,5,7,6
l,6,8,6

a,5,6,8,7

/com, Top

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k,10,0,(125.75/2)     ,0,0

l,9,10,10

local,11,1,0,(-75.75/4),0

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k,12,(81.8125),0,0

l,9,11
l,10,12

csys,0

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l,7,13
l,8,14

linter,12,14
linter,13,15

FLST,2,4,4,ORDE,2
FITEM,2,18
FITEM,2,-21
LDELE,P51X, , ,1

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!*
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CMDEL,_Y1
CMDEL,_Y2
!*

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FITEM,2,20
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FITEM,2,26
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/STAT,SOLU
SOLVE

FINISH
/POST1

LPATH,      87,       12
/out,press,out
PRSECT, ,0
/out

LPATH,    1915,     1916
/out,r-press,out
PRSECT, ,0
/out
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PRINT LINEARIZED STRESS THROUGH A SECTION DEFINED BY LPATH COMMAND. DSYS= 0

***** POST1 LINEARIZED STRESS LISTING *****
INSIDE NODE = 1915 OUTSIDE NODE = 1916

LOAD STEP 1 SUBSTEP= 1
TIME= 1.0000 LOAD CASE= 0

THE FOLLOWING X,Y,Z STRESSES ARE IN GLOBAL COORDINATES.

** MEMBRANE **

SX	SY	SZ	SXY	SYZ	SXZ
18.74	4522.	6645.	-8.552	.0000	.0000
S1	S2	S3	SINT	SEQV	
6645.	4522.	18.73	6626.	5861..	

** BENDING ** I=INSIDE C=CENTER O=OUTSIDE

	SX	SY	SZ	SXY	SYZ	SXZ
I	41.00	-3990.	-1158.	217.5	.0000	.0000
C	.0000	.0000	.0000	.0000	.0000	.0000
O	-41.00	3990.	1158.	-217.5	.0000	.0000
	S1	S2	S3	SINT	SEQV	
I	52.70	-1158.	-4001.	4054.	3605.	
C	.0000	.0000	.0000	.0000	.0000	
O	4001.	1158.	-52.70	4054.	3605.	

** MEMBRANE PLUS BENDING ** I=INSIDE C=CENTER O=OUTSIDE

	SX	SY	SZ	SXY	SYZ	SXZ
I	59.74	532.2	5487.	208.9	.0000	.0000
C	18.74	4522.	6645.	-8.552	.0000	.0000
O	-22.25	8512.	7802.	-226.0	.0000	.0000
	S1	S2	S3	SINT	SEQV	
I	5487.	611.3	-19.41	5507.	5220.	
C	6645.	4522.	18.73	6626.	5861.	
O	8518.	7802.	-28.24	8546.	8212.	

** PEAK ** I=INSIDE C=CENTER O=OUTSIDE

	SX	SY	SZ	SXY	SYZ	SXZ
I	-32.53	14.30	-6.590	-173.6	.0000	.0000
C	34.14	-37.83	-.5786	107.3	.0000	.0000
O	-81.95	198.6	33.73	-185.5	.0000	.0000
	S1	S2	S3	SINT	SEQV	
I	166.0	-6.590	-184.3	350.3	303.4	
C	111.3	-.5786	-115.0	226.3	196.0	
O	290.9	33.73	-174.2	465.1	403.5	

** TOTAL ** I=INSIDE C=CENTER O=OUTSIDE

	SX	SY	SZ	SXY	SYZ	SXZ
I	27.21	546.5	5481.	35.36	.0000	.0000
C	52.89	4484.	6644.	98.71	.0000	.0000
O	-104.2	8710.	7836.	-411.5	.0000	.0000
	S1	S2	S3	SINT	SEQV	TEMP
I	5481.	548.9	24.81	5456.	5214.	.0000
C	6644.	4486.	50.69	6594.	5823.	
O	8729.	7836.	-123.4	8853.	8442.	.0000

PRINT LINEARIZED STRESS THROUGH A SECTION DEFINED BY LPATH COMMAND. DSYS= 0

***** POST1 LINEARIZED STRESS LISTING *****
INSIDE NODE = 87 OUTSIDE NODE = 12

LOAD STEP 1 SUBSTEP= 1
TIME= 1.0000 LOAD CASE= 0

THE FOLLOWING X,Y,Z STRESSES ARE IN GLOBAL COORDINATES.

** MEMBRANE **

SX	SY	SZ	SXY	SYZ	SXZ
-29.90	4640.	9310.	.0000	.0000	.0000
S1	S2	S3	SINT	SEQV	
9310.	4640.	-29.90	9340.	8089.	

** BENDING ** I=INSIDE C=CENTER O=OUTSIDE

	SX	SY	SZ	SXY	SYZ	SXZ
I	-29.99	-.1950E-01	29.98	.0000	.0000	.0000
C	.0000	.0000	.0000	.0000	.0000	.0000
O	29.99	.1950E-01	-29.98	.0000	.0000	.0000
	S1	S2	S3	SINT	SEQV	
I	29.98	-.1950E-01	-29.99	59.97	51.93	
C	.0000	.0000	.0000	.0000	.0000	
O	29.99	.1950E-01	-29.98	59.97	51.93	

** MEMBRANE PLUS BENDING ** I=INSIDE C=CENTER O=OUTSIDE

	SX	SY	SZ	SXY	SYZ	SXZ
I	-59.89	4640.	9340.	.0000	.0000	.0000
C	-29.90	4640.	9310.	.0000	.0000	.0000
O	.8318E-01	4640.	9280.	.0000	.0000	.0000
	S1	S2	S3	SINT	SEQV	
I	9340.	4640.	-59.89	9400.	8141.	
C	9310.	4640.	-29.90	9340.	8089.	
O	9280.	4640.	.8318E-01	9280.	8037.	

** PEAK ** I=INSIDE C=CENTER O=OUTSIDE

	SX	SY	SZ	SXY	SYZ	SXZ
I	-.1086	.6217E-04	.1087	.0000	.0000	.0000
C	.4917E-01	-.1863E-04	-.4918E-01	.0000	.0000	.0000
O	-.8209E-01	.1016E-03	.8200E-01	.0000	.0000	.0000
	S1	S2	S3	SINT	SEQV	
I	.1087	.6217E-04	-.1086	.2173	.1882	
C	.4917E-01	-.1863E-04	-.4918E-01	.9835E-01	.8517E-01	
O	.8200E-01	.1016E-03	-.8209E-01	.1641	.1421	

** TOTAL ** I=INSIDE C=CENTER O=OUTSIDE

	SX	SY	SZ	SXY	SYZ	SXZ
I	-60.00	4640.	9340.	.0000	.0000	.0000
C	-29.85	4640.	9310.	.0000	.0000	.0000
O	.1086E-02	4640.	9280.	.0000	.0000	.0000
	S1	S2	S3	SINT	SEQV	TEMP
I	9340.	4640.	-60.00	9400.	8141.	.0000
C	9310.	4640.	-29.85	9340.	8089.	
O	9280.	4640.	.1086E-02	9280.	8037.	.0000

STRUCTURAL INTEGRITY Associates, Inc.

CALCULATION PACKAGE

FILE No: PSEG-07Q-302

PROJECT No: PSEG-07Q

PROJECT NAME: Salem Unit 1 Chemical and Volume Control Tank (1CVE6) Flaw Evaluation

CLIENT: Public Service Electric & Gas

CALCULATION TITLE: Section XI Flaw Evaluation

PROBLEM STATEMENT OR OBJECTIVE OF THE CALCULATION:

Based on stress analysis of the Chemical and Volume Control Tank, perform analysis to:

1) Determine the allowable flaw size(s)
2) Evaluate crack growth

Document Revision	Affected Pages	Revision Description	Project Mgr. Approval Signature & Date	Preparer(s) & Checker(s) Signatures & Date
0	1 – 13 A0 - A8 Project CD Rom	Original Issue	NGC 10/11/99	NGC 10/11/99 RLB 10/11/99
1	3, 5 - 7, 13, A0 – A7	Revised to address seismic stresses	[signature] 10/12/99	[signature] NGC 10/12/99 [signature] RLB 10-12-99

1.0 INTRODUCTION

During routine inspection of the chemical and volume control tank 1CVE6 at Salem Unit 1 during the 1999 outage (U1-RFO-13), two subsurface flaws were identified in the shell to lower head weld that exceeded the ASME Section XI allowable standard in IWB-3500. One flaw is located on the shell side while the other flaw is located on the head side of the weld. The dimensions of the flaws relative to the thickness of the shell and the head are shown in Figure 1 [1]. Using the proximity rules in ASME Section XI, IWA-3300, the two flaws can be treated as two separate flaws for analysis purposes. The tank is classified as ASME Section III, Class C but was inspected to ASME Class I requirements for flaw acceptance during the inspections [1]. The objective of this package is to perform an evaluation per ASME Section XI, IWB-3600 to determine the suitability of continued operation with these flaws.

2.0 TECHNICAL APPROACH

The CVC tank is fabricated from Type 304 stainless steel. The net section collapse methodology which is the basis for determining the allowable flaw size for austenitic stainless steel piping in ASME Section XI will be used as guidance to determine the allowable flaw size for the tank.

Since the flaws are subsurface and not in contact with the environment, the only possible mechanism for flaw growth is fatigue. Hence a very conservative fatigue growth evaluation will be performed to ensure that the identified flaws will not grow to the allowable flaw size during service.

3.0 GEOMETRY AND MATERIAL

The overall geometry of the CVC tank is provided in PSE&G Drawing 106425, Rev. 7 [2]. The inside diameter is 90 inches [2]. The thickness of the cylinder is 0.29 inches and that of the hemispherical head is 0.35 inches [1]. The material is ASTM A240 Type 304 [2].

It will be conservatively assumed that the fluxed welding process was used in welding the cylinder to the heads.

4.0 MATERIAL PROPERTIES

Material properties for ASTM A240 Type 304 stainless steel are taken from the ASME Code, Section III Appendices, 1989 Edition [3]. The maximum operating temperature of the tank is 127°F [4]. The properties at this temperature are as follows:

- Yield Strength, S_y: 28.65 ksi
- Ultimate Strength, S_u: 73.92 ksi
- Flow Stress, S_f: 51.285 ksi
- Design Stress Intensity, S_m: 20 ksi

It should be noted that the material flow stress, S_f is taken as the average of yield, S_y and ultimate, S_u. In Appendix C and IWB-3640 of ASME Section XI, the value of $3S_m$ or in this case 60 ksi is used in flaw evaluations. In this analysis, the conservative flow stress of 51.285 ksi will be used. This is appropriate since the component under evaluation is not a Class 1 component.

5.0 STRESSES

Stress analysis has been performed in Ref. 5 to determine the pressure stresses in the tank based on the maximum operating pressure of 60 psi. The operating temperature of the tank is so low that no significant thermal stresses are expected. Stresses at the critical paths in the analysis are presented in Table 1. It can be seen that the maximum axial stress, SY (relevant for circumferential flaws) is 4.64 ksi. This will be used in the allowable flaw size determination. The membrane plus bending stresses shown in Table 1 will be used in the allowable flaw size determination.

In addition to the operating pressure, there is a hydrostatic pressure of 4.5 psi at the bottom of the tank assuming the tank is completely full. There is also a maximum vertical seismic loading of 3.16 g [7]. This will therefore increase the hydrostatic pressure by a factor of 4.16 during a seismic event resulting in a total hydrostatic pressure of 18.72 psi. Hence, the pressure stresses determined in Ref. 5 and presented in Table 1 will be factored by 78.72/60 or 1.312. The horizontal seismic loading is not expected to affect the stresses at the flaw location since the loads will be transmitted through the legs of the tank and the portion of the tank above the support which is remote from the flaw location in the shell to lower head intersection.

6.0 ALLOWABLE FLAW SIZE DETERMINATION

The allowable flaw size in the CVC Tank is determined using a very conservative approach to bound the problem. Two types of analysis are performed using the net section plastic collapse approach in Appendix C of the ASME Section XI. In the first analysis, a conservative 360° flaw is assumed in the CVC tank and the allowable flaw depth is determined. In the second analysis, a through-wall flaw is assumed and the allowable circumferential extent of the flaw is determined.

There are no Section XI methods for evaluation of Class 2 and 3 austenitic components, therefore Class 1 methods in IWB-3600/Appendix C of the ASME Section XI will be applied. Also in IWB-3600, there are no criteria for austenitic material other than piping. Therefore guidance will be taken from the criteria for austenitic piping rules in IWB-3640.

The net section plastic collapse equations in Appendix C of ASME Section XI for austenitic stainless steel piping is provided as follows:

For circumferential flaws not penetrating the compressive side of the pipe such that $(\theta + \beta) \leq \pi$ (see Figure 2), the relation between the applied loads and flaw depth at incipient plastic collapse is given by:

$$P'_b = \frac{6S_m}{\pi}\left(2\sin\beta - \frac{a}{t}\sin\theta\right) \quad (1a)$$

where

$$\beta = \frac{1}{2}(\pi - \frac{a}{t}\theta - \pi\frac{P_m}{3S_m}) \quad (2a)$$

θ = half flaw angle

For longer flaws penetrating the compressive bending region where $(\theta + \beta) > \pi$, the relation between the applied loads and the flaw depth at incipient plastic collapse is given by:

$$P'_b = \frac{6S_m}{\pi}\left(2 - \frac{a}{t}\sin\beta\right) \quad (1b)$$

where

$$\beta = \frac{1}{2}(\pi - \frac{a}{t}\theta - \pi\frac{P_m}{3S_m}) \quad (2b)$$

θ = half flaw angle

Equations (1) and (2) are solved by trial and error for the allowable flaw depth using the measured flaw length and the applied loads with the appropriate factor of safety.

For fluxed weldments (shielded metal-arc welds (SMAW) and submerged arc welds (SAW)), the failure stress P'_b in equation (1) and (2) is given by:

$$P'_b = Z_1(P_m + P_b + P_e/SF) - P_m$$

where P_m = Primary Stress
P_b = Bending Stress
P_e = Expansion Stress
SF = Safety Factor
Z_1 = 1.15[1 + 0.013(OD-4)] for SMAW
= 1.30[1 + 0.010(OD-4)] for SAW
OD is the nominal pipe size, NPS, and for NPS <= 24 in., use O.D. = 24.

In application to the CVC tank, a diameter of 24 inches is used to calculate the value of Z_1. The conservative value of 1.56 for the SAW is used in the evaluation.

For the CVC tank, the only source of loading is pressure. Thus this analysis will use a safety factor of 3.0 instead of 2.77 for normal operating condition that are used for piping.

6.1 Evaluation of Circumferential Part and Through-Wall Flaw

For this analysis, it is assumed that the flaw extends 360° around the tank. Using the above equations, the allowable flaw a/t is approximately 0.65. Results are shown in Excel spreadsheet MAXPTWC.XLS.

6.2 Evaluation of Circumferential Part and Through-Wall Flaw

For this analysis, a value of $a/t = 1.0$ is assumed in the above equations to determine the allowable circumferential extent for the through-wall flaw. The analysis presented in spreadsheet MAXTWC.XLS shows that the allowable half angle is 74.5° which corresponds to a through-wall flaw around 41.3 percent of circumference.

7.0 CRACK GROWTH EVALUATION

A subcritical flaw growth analysis is performed to ensure that the identified flaws will not grow significantly during service. Since the two flaws can be treated as two separate flaws by ASME Section XI, IWA-3300 proximity rules, the most conservative of the two flaws is chosen for the flaw growth evaluation.

7.1 Stress Intensity Factor

Since the radius-to-thickness (R/t) ratio of the tank is relatively large, a model consisting of an elliptical subsurface cracked plate under membrane and bending, shown in Figure 3, chosen from the pc-CRACK [6] library to calculate the stress intensity factor (K). Both the membrane and through-wall bending stresses shown in Table 1 are used to calculate K as a function of crack depth as shown in Figure 4. In addition, yield level weld residual stresses are assumed which, even though do not cycle, affect the R-ratio used in the crack growth evaluation. The stress intensity factors for the membrane and bending stresses shown in Figure 4 are multiplied by 1.237 to account for the hydrostatic and seismic loading.

7.2 Crack Growth Law

Since the identified flaws are subsurface flaws, the ASME Section XI law for austenitic stainless steels in an air environment is used in the analysis. The ASME Code, Section XI fatigue crack growth law for air is given as:

$$\frac{da}{dN} = C_o(\Delta K_I)^n$$

where n equals 3.3, and

$$C_o = C(S)$$

where C is a scaling parameter to account for temperature, and is given by:

$$C = 10^{[-10.009 + 8.12 \times 10^{-4} T - 1.13 \times 10^{-6} T^2 + 1.02 \times 10^{-9} T^3]}$$

T is the metal temperature in °F ($T \leq 800$°F). S is a scaling parameter to account for the R ratio (K_{min}/K_{max}), and is given by:

S	=	1.0	when $R \leq 0$
	=	1.0 + 1.8R	when $0 < R \leq 0.79$
	=	-43.35 + 57.97R	when $0.79 < R \leq 1.0$

7.3 Results of Crack Growth Evaluation

The stress intensity factor distribution and the crack growth law in the previous sections are used to perform a crack growth analysis with an initial half flaw depth (a) of 0.06 inches and an aspect ratio (a/l) of 0.10. The analysis was performed by conservatively cycling between the weld residual stress and the maximum operating pressure plus hydrostatic plus seismic weld residual stress. After one thousand cycles, the initial flaw has grown to 1.1×10^{-5} inch, indicating that the crack growth is very benign when considering the fact that only 240 pressure cycles and 500 OBE cycles are encountered during the lifetime of the plant. Results of the analysis are shown in Figure 5. The pc-CRACK run for the crack growth evaluation is presented in Appendix A.

8.0 CONCLUSIONS

The fracture mechanics analysis contained in this calculation package has demonstrated that the chemical and volume control tank at Salem Unit 1, with the flaws identified during the 1999 outage, can operate safely without violating the safety margins in ASME Section XI. The following are highlights of the evaluation.

- The allowable flaw sizes are very large. Assuming a 360° circumferential flaw, the allowable flaw depth-to-thickness ratio is 65%. For a through-wall flaw, up to 41.3% of the circumference can be cracked without violating Section XI safety margins. This compares with subsurface flaw depths (2a) of 22.8% and 41.36% with lengths of 0.20 inches and 0.70 inches respectively identified during the inspection.

- Crack growth analysis considering 1000 pressurization cycles resulted in insignificant crack growth (1.1 x 10^{-5}inch) indicating that crack extension during operating is negligibly small.

- Since the flaws are subsurface and therefore not in contact with the environment, there is no other active crack growth mechanisms other than fatigue that can cause the flaws to grow during service.

9.0 REFERENCES

1. Framatome Technologies UT Data Package No. S1DP137, "Salem Unit 1 (U1-RFO-13), Chemical and Volume Control Tank, 1-CVT-2, Shell to Lower Head," dated 10/8/99, S.I. File PSEG-07Q-201

2. PSE&G Drawing No. 106425, Rev. 7, Westinghouse Drawing No. 110E019, "Volume Control Tank," S.I. File PSEG-07Q-202

3. ASME Boiler and Pressure Vessel Code, Section III, Appendices, 1989 Edition

4. Excerpt from Salem Unit 1 Configuration Baseline Document DE-CB.CVC-0037(Q), Rev. 0, "Table T-8, Component Design Data, Chemical and Volume Control System, Volume Control Tank (1CVE6)," S.I. File PSEG-07Q-203

5. S.I. Calculation No. PSEG-07Q-301, Rev. 0, "Stress Analysis of Chemical and Volume Control Tank."

6. pc-Crack for Windows Computer Software, Version 3.1, Structural Integrity Associates.

7. Franklin Institute Research Laboratory Inc. Technical Report No. 402-2530-002-9, Figures 13 through 16, "Response Spectra and Response Spectra Envelopes for the Salem Nuclear Generating Station" September 7, 1982, SI File PSEG-07Q-205.

Table 1
Stress Results [5]

Path 1 Stress Results

Surface	SX	SY	SZ	SXY	SYZ	SXZ	S1	S2	S3	SINT
Membrane Stresses (psi)										
	18.74	4522	6645	-8.552	0	0	6645	4522	18.73	6626
Bending Stresses (psi)										
Inside	4100	-3990	-1158	218	0	0	52.7	-1158	-4001	4054
Center	0.000	0000	0.000	0.000	0	0	0.000	0.000	0.000	0.000
Outside	-4100	3990	1158	-218	0	0	4001	1158	52.7	4054
Membrane Plus Bending Stresses (psi)										
Inside	59.74	532.2	5487	208.9	0	0	5487	611.3	-19.41	5507
Center	18.74	4522	6645	-8.552	0	0	6645	4522	18.73	6626
Outside	-22.25	8512	7802	-226	0	0	8518	7802	-28.24	8546

Path 2 Stress Results

Surface	SX	SY	SZ	SXY	SYZ	SXZ	S1	S2	S3	SINT
Membrane Stresses (psi)										
	-29.9	4640	9310	0	0	0	9310	4640	-29.9	9340
Bending Stresses (psi)										
Inside	-29.99	-0.020	29.98	0	0	0	29.98	-0.020	-29.99	59.97
Center	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000	0.000
Outside	29.99	0.020	-29.98	0	0	0	29.99	0.020	-29.98	59.97
Membrane Plus Bending Stresses (psi)										
Inside	-59.89	4640	9340	0	0	0	9340	4640	-59.89	9400
Center	-29.9	4640	9310	0	0	0	9310	4640	-29.9	9340
Outside	0.0832	4640	9280	0	0	0	9280	4640	0.0832	9280

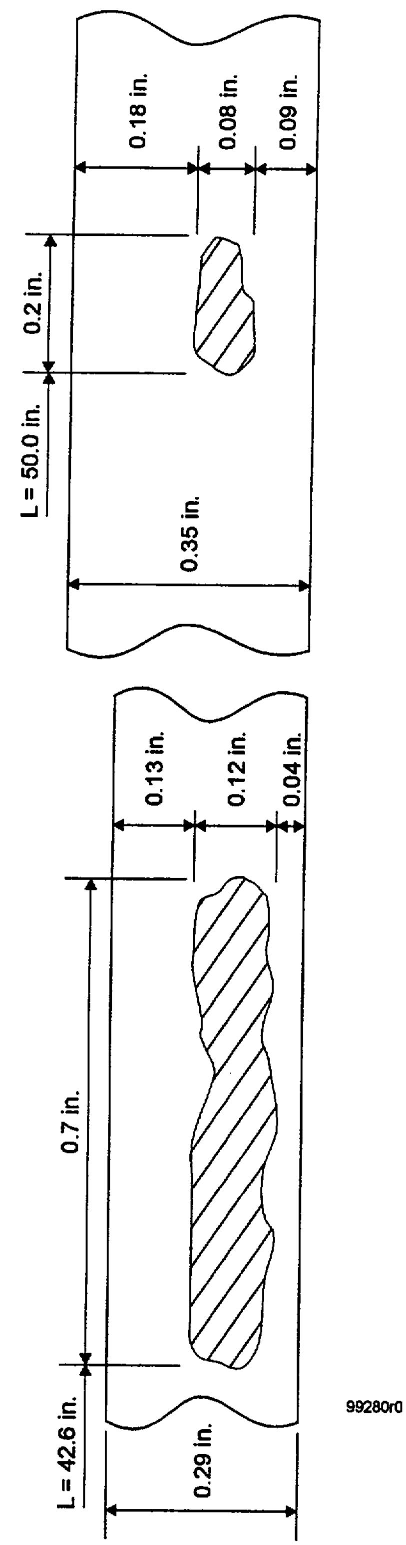

Figure 1. Flaw Dimensions

Revision	0	1		
Preparer/Date	NGC 10/11/99	NGC 10/12/99		
Checker/Date	RLB 10/11/99	RLB 10-12-99		

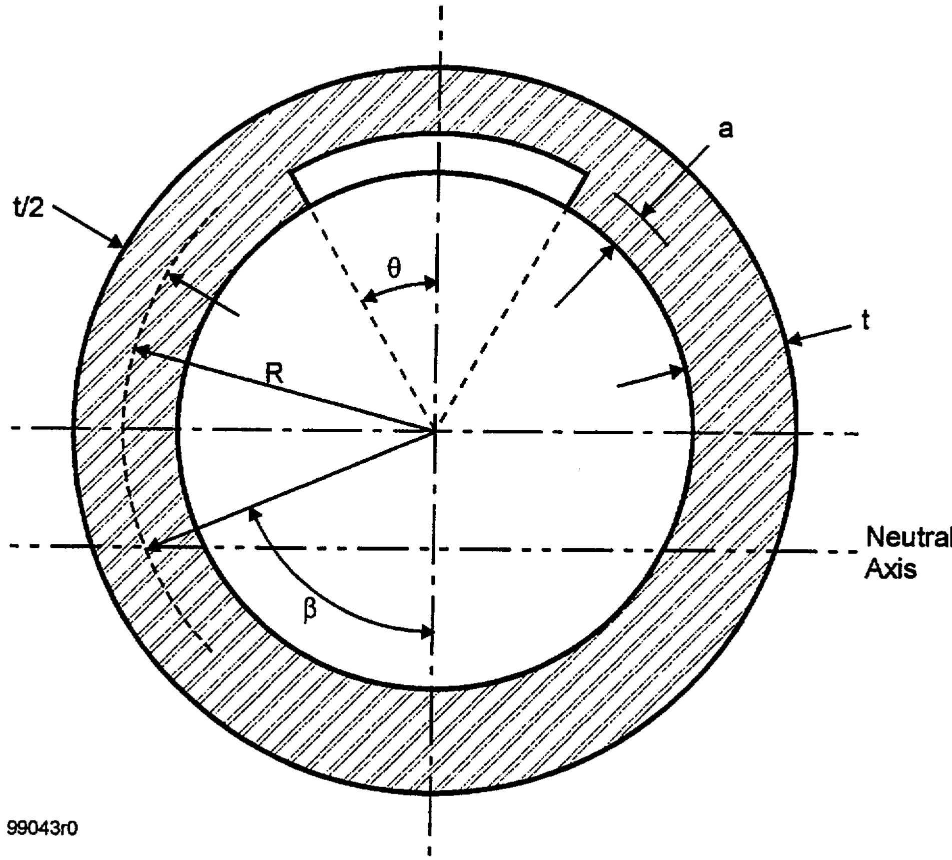

Figure 2. Assumed Flaw in Net Section Plastic Collapse Analysis

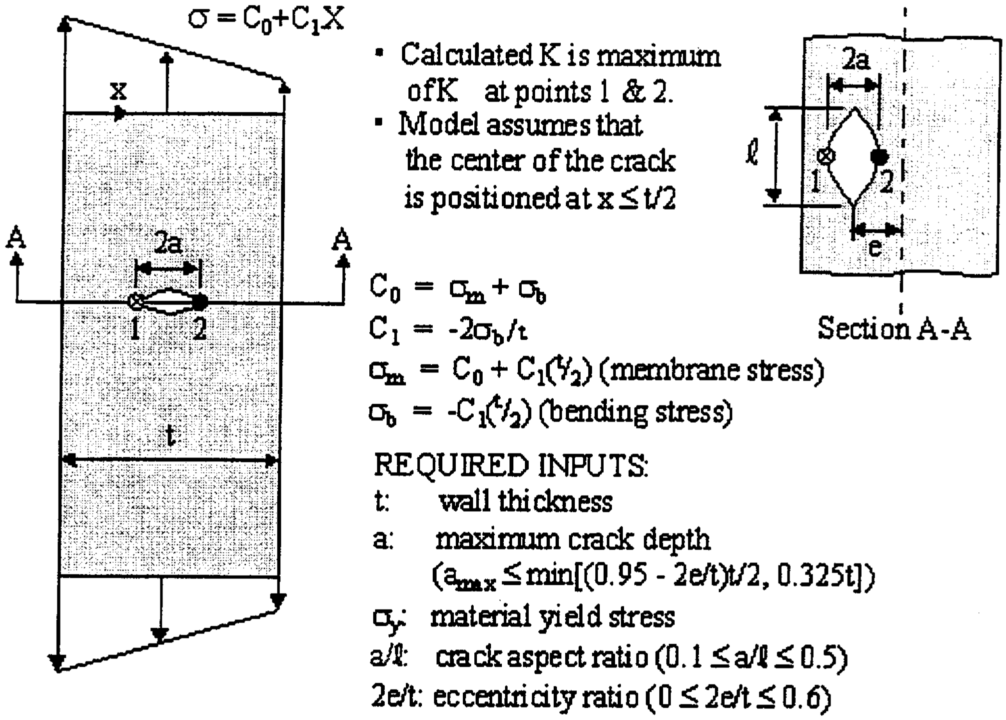

Figure 3. Elliptical Subsurface Cracked Plate Under Membrane and Bending Stresses Model

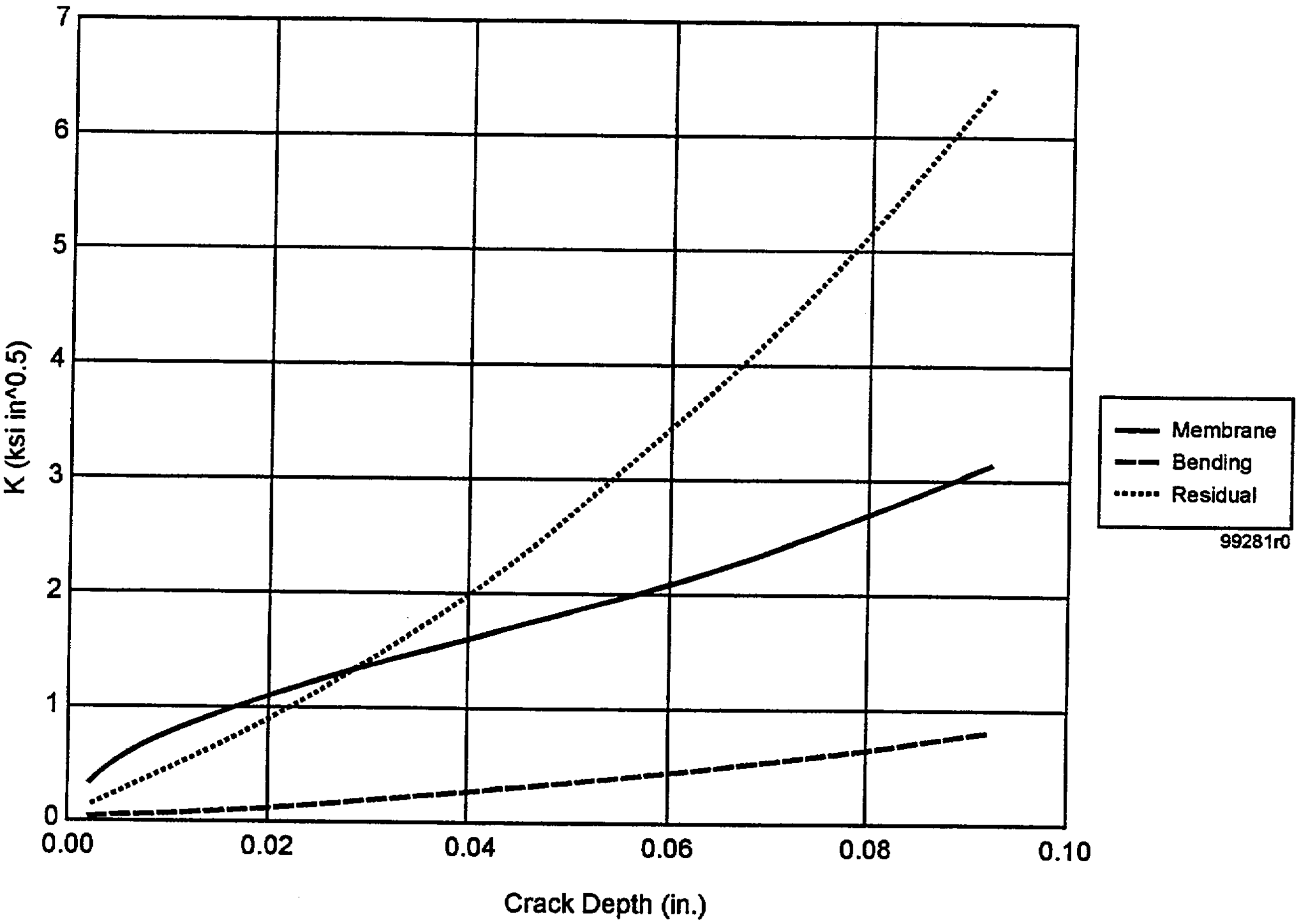

Figure 4. Stress Intensity Factor Versus Crack Depth

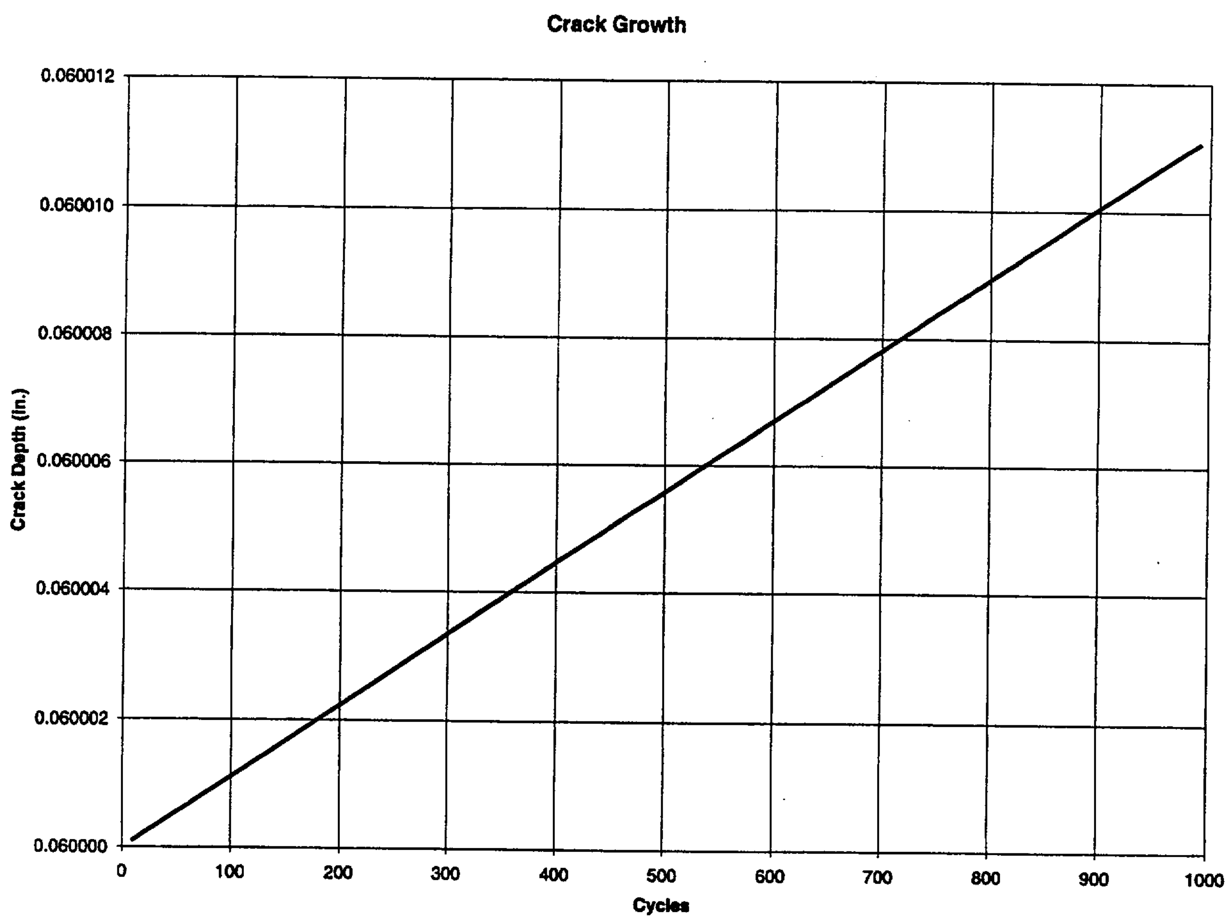

Figure 5. Results of Crack Growth Evaluation

APPENDIX A

pc-CRACK for Windows Output for Fatigue Crack Growth

pc-CRACK™ for Windows
Version 3.1-98348

Structural Integrity Associates, Inc.
3315 Almaden Expressway, Suite 24
San Jose, CA 95118-1557
Voice: 408-978-8200
Fax: 408-978-8964
E-mail: pccrack@structint.com

Linear Elastic Fracture Mechanics

Date: Tue Oct 12 16:05:25 1999
Input Data and Results File: CRCKGRW1.LFM

Title: Salem Unit 1 Chemical and Volume Control Tank Flaw Evaluation

Load Cases:

Case ID	Stress Coefficients C0	C1	C2	C3	Type
Membrane	4.522	0	0	0	Coeff
Bending	3.99	-27.517	0	0	Coeff
Residual	28.65	-197.586	0	0	Coeff

------Through Wall Stresses for Load Cases With Stress Coeff-------

Wall Depth	Case Membrane	Case Bending	Case Residual
0.0000	4.522	3.99	28.65
0.0092	4.522	3.73684	26.8322
0.0184	4.522	3.48369	25.0144
0.0276	4.522	3.23053	23.1966
0.0368	4.522	2.97737	21.3788
0.0460	4.522	2.72422	19.561
0.0552	4.522	2.47106	17.7433

0.0644	4.522	2.21791	15.9255
0.0736	4.522	1.96475	14.1077
0.0828	4.522	1.71159	12.2899
0.0920	4.522	1.45844	10.4721

Crack Model: Elliptical Subsurface Cracked Plate Under Membrane & Bending Stresses

Reference: ASME Boiler and Pressure Vessel Code, Section XI, '86 Ed.
WARNING: The stress intensity factor (K) is the maximum of
K at point 1 and K at point 2 as identified in Section XI.

Crack Parameters:
Wall thickness: 0.2900
Max. crack depth: 0.0920
Crack aspect ratio: 0.1000
Eccentricity ratio: 0.0450
Material yield strength: 28.6500
Co = Sigma(membrane) + Sigma(bending)
C1 = -2*Sigma(bending)/thickness

	--------------------Stress Intensity Factor--------------------		
Crack Size	Case Membrane	Case Bending	Case Residual
0.0018	0.32672	0.0153693	0.122582
0.0037	0.462499	0.0245998	0.196205
0.0055	0.566991	0.0336365	0.268285
0.0074	0.655337	0.0428908	0.342101
0.0092	0.733396	0.0524822	0.418607
0.0110	0.804169	0.0624525	0.498135
0.0129	0.869439	0.072815	0.580792
0.0147	0.930363	0.0834942	0.665976
0.0166	0.987748	0.093953	0.749402
0.0184	1.04218	0.104721	0.835293
0.0202	1.09409	0.115795	0.923632
0.0221	1.14438	0.127173	1.01439
0.0239	1.19541	0.138848	1.10752
0.0258	1.245	0.150817	1.20299
0.0276	1.29332	0.163074	1.30076
0.0294	1.34051	0.175615	1.40079

0.0313	1.38668	0.188433	1.50304
0.0331	1.43194	0.201524	1.60746
0.0350	1.47638	0.214883	1.71403
0.0368	1.52091	0.228507	1.8227
0.0386	1.56682	0.242389	1.93343
0.0405	1.61224	0.256526	2.0462
0.0423	1.65722	0.270915	2.16098
0.0442	1.70179	0.28597	2.28107
0.0460	1.74599	0.302054	2.40936
0.0478	1.78986	0.318423	2.53994
0.0497	1.83343	0.335075	2.67277
0.0515	1.87837	0.352004	2.8078
0.0534	1.92546	0.369205	2.94502
0.0552	1.97245	0.386675	3.08437
0.0570	2.01937	0.40441	3.22584
0.0589	2.06622	0.422406	3.36938
0.0607	2.11302	0.440658	3.51498
0.0626	2.15978	0.459164	3.6626
0.0644	2.20652	0.47792	3.81221
0.0662	2.25867	0.496923	3.96379
0.0681	2.31568	0.51617	4.11732
0.0699	2.37298	0.535657	4.27276
0.0718	2.43055	0.555382	4.4301
0.0736	2.4884	0.576222	4.59634
0.0754	2.54654	0.597916	4.76939
0.0773	2.60496	0.619876	4.94456
0.0791	2.66367	0.642099	5.12182
0.0810	2.72836	0.66458	5.30116
0.0828	2.79646	0.687318	5.48253
0.0846	2.86505	0.71031	5.66593
0.0865	2.93412	0.733552	5.85133
0.0883	3.00366	0.757043	6.03871
0.0902	3.07369	0.780779	6.22805
0.0920	3.14418	0.804758	6.41932

Crack Growth Laws:

Law ID: Stainless
Model: ASME Section XI - austenitic stainless steel in 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

= -43.5 + 57.97 * R for 0.79 < R < 1

F = code specified function of temperature

dK = Kmax - Kmin

R = Kmin / Kmax

where:

C * 10^F = 1.1951e-010

is for the currently selected units of:

force: kip

length: inch

temperature: 127.0000 Fahrenheit

Material Fracture Toughness KIc:

Material ID: Stainless

Depth	KIc
0.0000	200.0000
0.1450	200.0000
0.2900	200.0000

Initial crack size= 0.0600

Max. crack size= 0.0920

Number of blocks= 1

Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
sub1	1000	1	10	Stainless	Stainless

Subblock	Kmax Case ID	Kmax Scale Factor	Kmin Case ID	Kmin Scale Factor
sub1	Membrane	1.3120	Residual	1.0000
	Bending	1.3120		
	Residual	1.0000		

Crack growth results:

Total Cycles /Time	Subblock Cycles /Time	Kmax	Kmin	DeltaK	R	DaDn /DaDt	Da	a	a/thk
Block:	1								
10	10	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
20	20	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
30	30	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
40	40	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
50	50	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
60	60	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
70	70	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
80	80	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
90	90	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
100	100	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
110	110	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
120	120	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
130	130	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
140	140	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
150	150	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
160	160	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
170	170	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
180	180	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
190	190	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
200	200	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
210	210	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
220	220	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
230	230	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
240	240	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
250	250	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21

260	260	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
270	270	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
280	280	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
290	290	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
300	300	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
310	310	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
320	320	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
330	330	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
340	340	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
350	350	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
360	360	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
370	370	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
380	380	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
390	390	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
400	400	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
410	410	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
420	420	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
430	430	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
440	440	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06	0.21
450	450	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
460	460	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
470	470	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
480	480	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
490	490	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
500	500	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
510	510	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
520	520	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
530	530	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
540	540	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
550	550	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
560	560	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
570	570	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
580	580	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
590	590	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
600	600	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
610	610	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
620	620	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
630	630	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
640	640	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
650	650	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
660	660	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
670	670	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21

680	680	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
690	690	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
700	700	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
710	710	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
720	720	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
730	730	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
740	740	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
750	750	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
760	760	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
770	770	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
780	780	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
790	790	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
800	800	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
810	810	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
820	820	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
830	830	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
840	840	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
850	850	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
860	860	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
870	870	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
880	880	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
890	890	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
900	900	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
910	910	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
920	920	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
930	930	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
940	940	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
950	950	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
960	960	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
970	970	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
980	980	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
990	990	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21
1000	1000	6.78e+000	3.46e+000	3.32e+000	0.51	1.20e-008	1.20e-008	0.06001	0.21

End of pc-CRACK Output