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James A. Fitzpatrick Nuclear Power Station
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Enclosure 2

Structural Integrity Associates Calculation 0800769.311
Crack Growth Analysis for Recirculation Inlet Nozzle N-2C

Structural Integrity Associates, Inc. **CALCULATION PACKAGE**	**File No.: 0800769.311** **Project No.: 0800769** Quality Program: ☒ Nuclear ☐ Commercial

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Entergy Nuclear Operations, Inc.	JA Fitzpatrick

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Crack Growth Analysis for Recirculation Inlet Nozzle N-2C

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1.0 INTRODUCTION/OBJECTIVE

An axially oriented, surface-connected indication was found in the recirculation inlet nozzle-to-safe end, N-2C-SE, dissimilar metal weld (DMW) during the September 2008 refueling outage at J.A. Fitzpatrick Nuclear Power Plant (JAF). This indication is elliptical and is located in the weld and weld butter.

The purpose of this calculation package is to apply linear elastic fracture mechanics (LEFM) to calculate crack growth in the nozzle-to-safe end dissimilar metal weld (DMW) for the reactor pressure vessel (RPV) recirculation inlet nozzle N-2C at JAF. Loads considered are internal pressure and weld overlay (WOL) repair residual stresses. Both fatigue crack growth (FCG) and Intergranular Stress Corrosion Cracking (IGSCC) are considered.

2.0 METHODOLOGY

The allowable end-of-evaluation period flaw depth to thickness ratio (a/t) was taken from Table IWB-3641-3, which is derived by the methodology of Appendix C of ASME Code, Section XI [1]. The geometry and design pressure for the N-2C nozzle is documented in a separate design input calculation [2]. The post-weld overlay (WOL) repair residual hoop stresses are documented in a separate stress analysis calculation [3].

Crack growth is computed using linear elastic fracture mechanics (LEFM) techniques. IGSCC growth is determined by computing the stress intensity factor versus flaw depth curve (K-vs.-a) at steady state normal operating conditions. Crack growth laws for Alloy 600 weld metals (Alloy 82/Alloy 182) are used at the susceptible DMW material region [1]. The time for the observed flaw to grow to 75% of the weld thickness is determined, with and without the benefit of WOL residual stresses.

The crack growth analysis was performed using the LEFM analysis option in **pc-CRACK for Windows™** software [7]. This software includes options for the evaluation of FCG and IGSCC, and allows for defining load cases, material properties, crack models, and the selection of the applicable crack growth law. Appendix B contains **pc-CRACK** output of the IGSCC and FCG growth analyses.

3.0 FLAW CHARACTERIZATION

The inspection results were provided in Reference [5], and are included in Appendix A of this calculation. The indication is a semi-elliptical surface connected flaw, bounded by parameters $l = 0.8$" and $a = 0.51$". Figure 1 shows an illustration of the crack model used in this analysis.

This indication was evaluated and shown to satisfy the requirements of Appendix C and Table IWB-3641-3 [1].

- Current a/t = 0.51/1.2188 = 0.42
- Stress Ratio = $(PD/2t)/S_m$ = 7.371/23.3 = 0.32
- Nondimensional Flaw Length = $l_f/(rt)^{0.5} = 0.8/(7.1875*1.2188)^{1/2} = 0.27$
- Allowable a/t = 0.75

The indication was also evaluated after implementation of the WOL repair. The locally increased wall thickness (design minimum value of 0.41" [3]) reduces the a/t ratio from 0.42 to 0.31.

4.0 DESIGN INPUTS

4.1 Materials and Geometry

Details of the recirculation inlet nozzle materials and geometry are provided in References [2] and [3]. The section evaluated for crack growth, and considered representative for the susceptible material region, is described below:

Material (Safe End):	SA-182 F304 low carbon
Material (Nozzle):	SA-508 Class 2
Material (Weld):	Alloy 82/182
Pressure (P) [1]:	1250 psi

Outside radius	OR = 7.1875 in.
Inside radius[2]	IR = 5.96875 in.
Thickness	t = 1.2188 in.
Pipe cross-sectional	Area= $\pi(OR^2-IR^2)$ = 50.37 in^2
Section modulus	$Z=\pi/4(OR^4-IR^4)/OR$ = 152.93 in^3

Note 1: The pressure used for analysis is the vessel design pressure [2], which is approximately equal to the recirculation system operating pressure.
Note 2: IR measurement is radius to base metal less cladding thickness.

4.2 Loading

Loads considered in this evaluation are internal pressure and WOL residual stresses. Bending stresses are oriented parallel to the observed axial flaw, and do not affect such a flaw. Hoop stresses tend to open an axial flaw, and are due entirely to internal pressure. The through-wall residual stress distributions are curve fit with a third order polynomial in the form shown below:

$$\sigma(x) = C_0 + C_1x + C_2x^2 + C_3x^3 \qquad (1)$$

where:

σ = stress (axial or hoop)
x = distance from the inside surface

Residual stress results were obtained for through-wall paths in the susceptible material regions. The paths used are as defined in Figure 2. It is important to note that the critical paths selected within the susceptible material regions have different path lengths. The intent for this approach is to characterize the residual stresses for each of the different loading conditions for three different locations within the DMW. Applied stress intensity factors are conservatively computed for one representative section using the most limiting path of the three paths analyzed. Residual stresses have a strong effect on IGSCC growth. They have a much less significant effect on fatigue crack growth, since they are steady state secondary stresses, and contribute to FCG only through a mean stress effect.

Internal Pressure

The pressure stress is evaluated at the design pressure, 1250 psi. Given this pressure and the nozzle geometry the primary hoop stress (P_{hoop}) is calculated as follows:

Primary hoop stress P_{hoop} = circumferential pressure stress= P*(OR)/t= 7371 psi.

Note that in this formulation, the OR is used, rather than the IR, which accounts for pressure on the crack face. In addition, the thin wall formula is used per the guidance in ASME Section XI, Appendix C, section C-3410 [1], which results in a conservatively higher calculated hoop stress than would result from using the thick wall formula used in Reference [3]. This value of P_{hoop} is assumed to be constant through the thickness and is represented by the C_0 coefficient from Equation (1).

WOL Residual Stresses

The residual stresses which result from implementing a weld repair are developed from the ANSYS model described in Reference [4]. The values of stresses are given for 70°F and 551°F. These stresses vary across the thickness and are represented by the curve fit Equation 1. These stresses are obtained using the ANSYS output files "RSDUAL_70F.RES" and "RSDUAL_551F.RES", and they are digitized using **pc-CRACK** to perform the curve fit. Three paths were investigated and the bounding paths for hoop stress within the DMW region were determined by calculating the K-vs-a curves within **pc-CRACK**, Figure 3. These bounding residual stresses are used for the crack growth analysis.

5.0 ASSUMPTIONS

Basic assumptions for the analysis are listed below:

- The through-wall residual stress distribution is sufficiently represented with a third order polynomial curve fit.
- This residual stress is considered in addition to the applied membrane stress calculated above. Weld residual stresses are steady state secondary stresses.
- Bending stresses are oriented parallel to the observed flaw and, therefore, do not affect the observed axially oriented flaw.

6.0 CRACK GROWTH CALCULATIONS

6.1 Fatigue Crack Growth (FCG)

FCG is calculated using the loading described in section 4.2. The minimum stress intensity K_{min} is taken as the weld repair residual hoop stress distribution at 70°F, which is present when the plant is shutdown. Path 2 from Figure 3 is bounding at 70°F. The maximum stress intensity K_{max} is the combination of the pressure hoop stress and the residual hoop stress at 551°F. Path 1 from Figure 3 is bounding at 551°F. This stress intensity range represents the range seen from shutdown to startup. The FCG after 10,000 applied cycles is calculated using **pc-CRACK** software using the crack growth law for austenitic material in air, as described by Figure C-3210-1 in Section XI Appendix C of the ASME Code [1]. Note that 10,000 cycles was an arbitrary number chosen as the limit of the **pc-CRACK** calculations. Section XI does not yet provide a FCG correlation for austenitic materials in a water environment. Appendix B contains output files for FCG with and without WOL residual stresses.

The stress intensity components of K_{max} and K_{min} for the weld overlay case are shown below. For the condition where residual stresses were not considered, the $K_{residual}$ components do not apply.

K_{max}	K_{min}
$K_{residual\ 551}$	$K_{residual\ 70}$
$K_{pressure}$	

6.2 Intergranular Stress Corrosion Cracking (IGSCC)

For IGSCC, the applied K (K_{max} above) is the crack driving force. The time needed to grow the crack to 75% through the as-repaired wall thickness is calculated. PVP2008-61299 [6] provides stress corrosion crack growth laws for high nickel base austenitic alloys. Fitzpatrick is on hydrogen water chemistry (HWC) [8]. Therefore, the HWC case is evaluated.

The SCC growth law is:

$$\frac{da}{dt} = C_o K_I^n \text{ in/hr for } K_I \leq 25 \text{ ksi}\sqrt{\text{in}} \qquad (2)$$

$$\frac{da}{dt} = C_1 \text{ in/hr for } K_I > 25 \text{ ksi}\sqrt{\text{in}} \qquad (3)$$

where,

Water Chemistry	C_0	C_1	n
Hydrogen	3.2E-10	5.0E-06	3.0
K_I = stress intensity factor at flaw tip (ksi√in)			

The K-dependent crack growth rates are calculated with **pc-CRACK** using the coefficients shown above and the K values developed within the software. For this evaluation the K-independent crack growth rates were not used since the combined stress intensity factor was never greater than +25 ksi√in, as seen in Figure 3. Appendix B contains **pc-CRACK** output files for the following cases:

- IGSCC case without residual stresses.
- FCG case without residual stresses.
- IGSCC case with WOL residual stresses.
- FCG case with WOL residual stresses.

The **pc-CRACK** and **ANSYS** computer files used in this evaluation are listed below.

File Name	Description
RSDUAL_70F.RES	**ANSYS** Residual Stress Output at 70°F
RSDUAL_551F.RES	**ANSYS** Residual Stress Output at 551°F
FCG-NO_RSDL.OUT	**pc-CRACK** Output File for Fatigue Crack Growth with Weld Overlay and without Residual Stresses
FCG-WOL.OUT	**pc-CRACK** Output File for Fatigue Crack Growth with Weld Overlay and considering Residual Stresses
IGSCC_HWC-NO_RSDL.OUT	**pc-CRACK** Output File for IGSCC with Weld Overlay, Hydrogen Water Chemistry and without Residual Stresses
IGSCC_HWC-WOL.OUT	**pc-CRACK** Output File for IGSCC with Weld Overlay, Hydrogen Water Chemistry and considering Residual Stresses
N2.LFM	**pc-CRACK** Input File for Recirculation Inlet Nozzle N-2

7.0 RESULTS AND CONCLUSIONS

This evaluation shows that the indication found during 2008 inspection of the JAF N-2C nozzle-to-safe end weld is acceptable and meets the requirements of ASME Code, Section XI, Appendix C and Table IWB-3641-3 [1]. Table 1 provides a summary of the calculation results. The additional wall thickness provided by the WOL repair will allow for another 20 years of operation even when conservatively ignoring the beneficial effects WOL residual stresses. However, the WOL residual stresses provide a significant benefit to the mitigation of crack growth, especially for IGSCC growth. Taking credit for these residual stresses produces a negative stress intensity factor, resulting in no further crack growth at this location.

8.0 REFERENCES

1. ASME Boiler & Pressure Vessel Code, Section XI, 2001 Edition, with Addenda through 2003.

2. SI Calculation No. 0800769.301, Rev. 0, "Design Input for RPV Recirculation Inlet & Outlet Nozzle Finite Element Analyses and Flaw Evaluation Readiness."

3. SI Calculation No. 0800769.302, Rev. 3, "Contingency Dissimilar Metal Weld Overlay Design for Recirculation Inlet Nozzle for Fitzpatrick."

4. SI Calculation No. 0800769.307, Rev. 2, "Residual Stress Analysis of Recirculation Inlet Nozzle with and without Weld Overlay Repair."

5. Hitachi Customer Notification Form (CNF-001R1), "N-2C-SE Indication Parameters," dated September, 26, 2008, SI File No. 0800769.201.

6. ASME Paper PVP2008-61299, "Nickel Alloy Crack Growth Correlations in BWR Environment and Application to Core Support Structure Welds Evaluation," July, 2008, SI File No. BWRVIP-01-259P.

7. **pc-CRACK** for Windows, Version 3.1-98348, Structural Integrity Associates, 1998.

8. James A. FitzPatrick Nuclear Power Plant License Renewal Application, Appendix A, Section A.2.1.33

Table 1: Results Summary

IGSCC	Water Chem	Time		Crack Growth
		hours	years	
No Residual Stresses	Hydrogen	175200	20	0.0849 in
With Residual Stresses	Hydrogen	175200	20	No Growth

FCG	Without Residual Stresses	0.0048 in
	With Residual Stresses	No Growth

Note 1: Fatigue crack growth calculations are for 10,000 transient cycles.

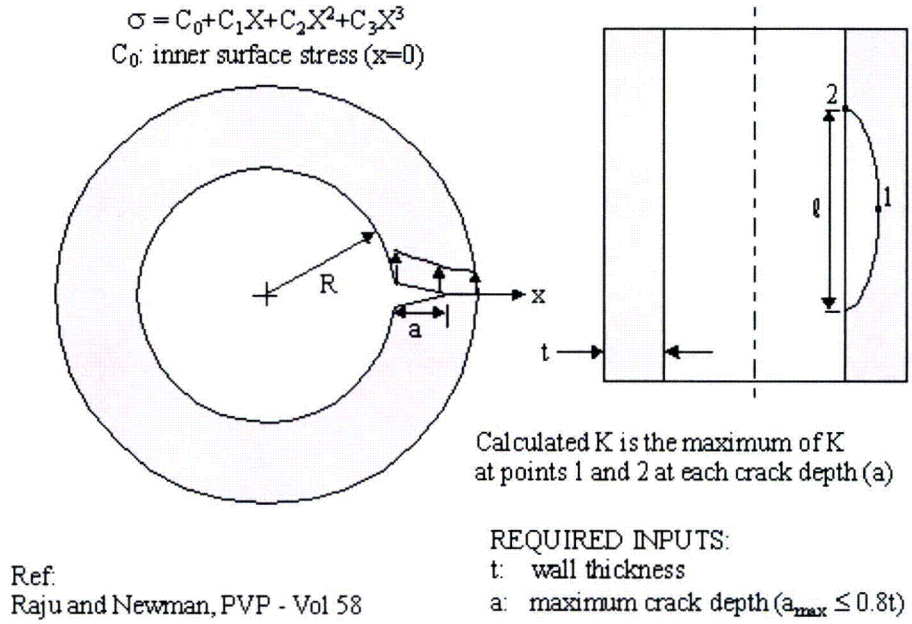

Figure 1. Crack Model: Elliptical Longitudinal Crack in a Cylinder (a/l=0.1)

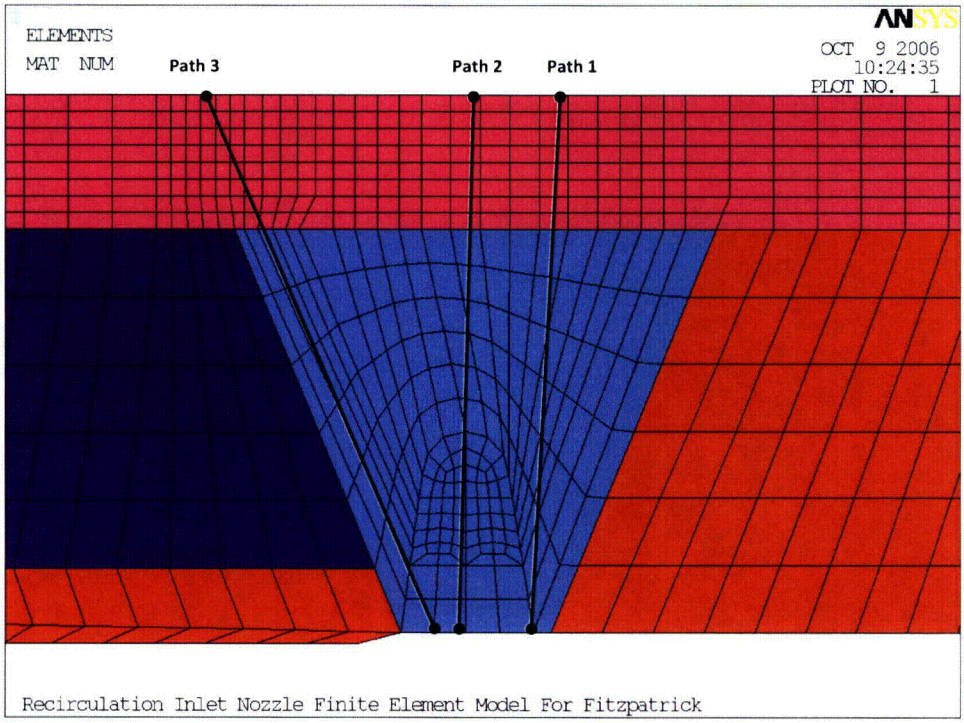

Figure 2. Path Definitions

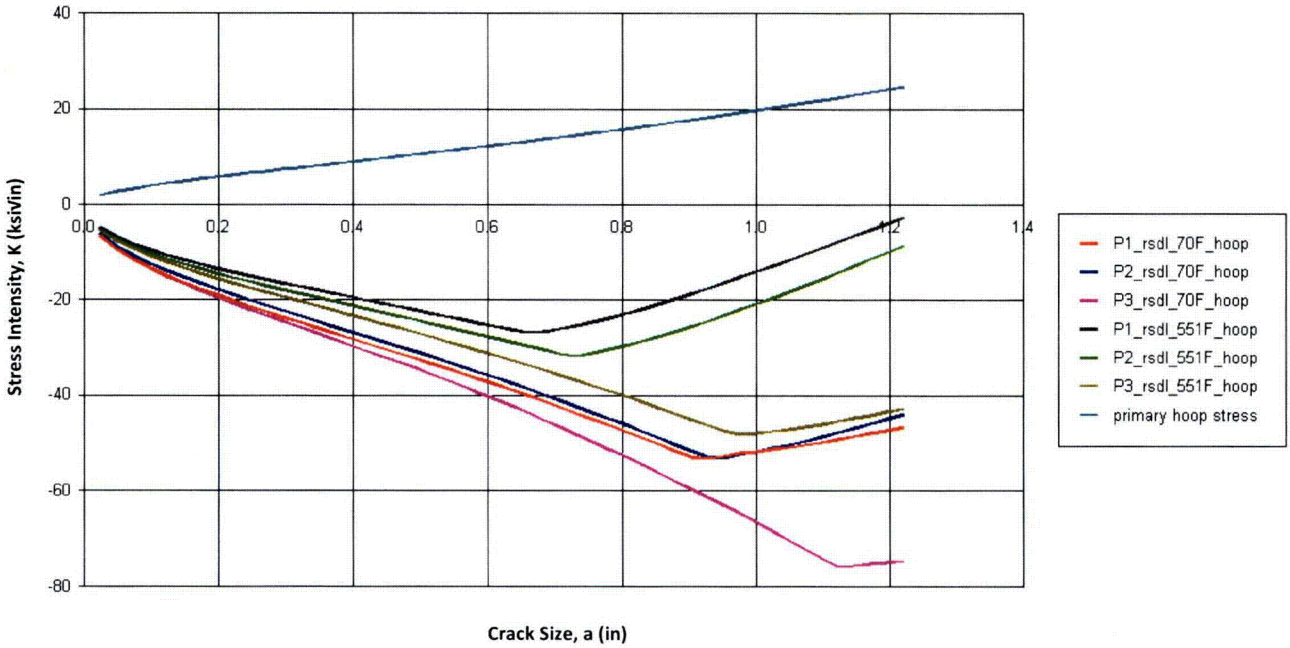

Figure 3. Fracture Mechanics Results, K-vs-a Curve (from pc-CRACK)

Appendix A

FLAW INDICATION PARAMETERS

HITACHI

Customer Notification Form (CNF)

Project:	J. A. Fitzpatrick RO-18	**Project No.:**			CNF-001 R1
Component Identification:	N-2C-SE	Code Cat. B-F	Item No.: B5.10	**Date:**	Sept. 26, 2008

Subject: N-2C-SE Indication Parameters

Data Sheet:	**Examination:**	**Work Order Number:**
N/A	Auto UT	125346

Indication is located 42.3" clockwise from Top Dead Center from -0.4" to 0.4" either side of weld centerline. Indication depth is 0.51".

Prepared By:	**Title:**	**Signature**
Paul Johnson	NDE Level III Data Analyst	Paul Johnson
Received By:	**Title:**	**Signature:**
D.B. King	NDE Level III	9-26-08

Appendix B

PC-CRACK OUTPUT FILES

Output for IGSCC case without residual stresses:

tm
pc-CRACK for Windows
Version 3.1-98348
(C) Copyright '84 - '98
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: Mon Dec 01 15:37:11 2008
Input Data and Results File: N2.LFM

Title: JAF N2 Crack Growth Without Residual Stresses

Load Cases:

Case ID: P1_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-39.7170
0.0793	-40.3490
0.1587	-40.7120
0.2380	-40.9920
0.3173	-40.0580
0.3967	-36.4000
0.4760	-30.3220
0.5553	-22.7690
0.6347	-12.5050
0.7140	-1.5176
0.7933	3.8362
0.8727	6.5966
0.9520	8.8339
1.0313	10.6030
1.1107	11.4380
1.1900	11.8810
1.2693	13.8740

1.3487	17.0970
1.4280	18.6230
1.5073	18.0990
1.5867	15.5500

Case ID: P2_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-40.6750
0.0792	-38.7950
0.1584	-36.3090
0.2376	-35.6780
0.3168	-38.8330
0.3960	-33.5040
0.4752	-39.3260
0.5544	-36.5530
0.6336	-21.1880
0.7128	-4.6270
0.7920	9.1298
0.8712	15.3010
0.9503	16.8200
1.0295	16.7900
1.1087	15.8530
1.1879	14.3480
1.2671	15.4520
1.3463	20.0010
1.4255	24.3720
1.5047	27.8520
1.5839	29.3440

Case ID: P3_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-38.4610
0.0853	-39.5790
0.1707	-49.1040
0.2560	-51.6050
0.3413	-51.2820
0.4266	-47.4160
0.5120	-41.6810
0.5973	-32.7260
0.6826	-20.8590
0.7679	-9.6705

0.8533	-0.2673
0.9386	7.0081
1.0239	8.3770
1.1093	9.4758
1.1946	9.1873
1.2799	9.0162
1.3652	11.2680
1.4506	15.8210
1.5359	18.7370
1.6212	21.4980
1.7065	23.6410

Case ID: P1_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-26.5210
0.0793	-26.9270
0.1587	-26.9240
0.2380	-26.3780
0.3173	-24.6910
0.3967	-20.6710
0.4760	-14.6190
0.5553	-7.2662
0.6347	2.3816
0.7140	12.6720
0.7933	17.6200
0.8727	20.1090
0.9520	22.0400
1.0313	23.5030
1.1107	22.1790
1.1900	20.0260
1.2693	17.4550
1.3487	20.1960
1.4280	21.3010
1.5073	20.4310
1.5867	17.8390

Case ID: P2_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-32.6410
0.0792	-30.4050
0.1584	-26.2400

0.2376	-23.6480
0.3168	-25.6030
0.3960	-20.0130
0.4752	-25.0810
0.5544	-22.2480
0.6336	-7.8169
0.7128	7.6241
0.7920	20.3840
0.8712	26.0170
0.9503	27.2700
1.0295	27.0450
1.1087	24.8660
1.1879	20.2130
1.2671	16.8180
1.3463	20.8460
1.4255	24.6800
1.5047	27.6550
1.5839	28.8950

Case ID: P3_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-29.0710
0.0853	-31.1390
0.1707	-37.1380
0.2560	-38.5510
0.3413	-37.6290
0.4266	-34.0970
0.5120	-29.0900
0.5973	-20.9770
0.6826	-10.0800
0.7679	0.1012
0.8533	8.4945
0.9386	14.8890
1.0239	15.7350
1.1093	16.1220
1.1946	13.6400
1.2799	11.2460
1.3652	8.7844
1.4506	12.6900
1.5359	15.0840
1.6212	17.3120
1.7065	19.0350

Case ID	Stress Coefficients C0	C1	C2	C3	Type
P1_rsdl_70F_hoo	-42.6891	-7.07378	115.185	-56.0956	StressDist
P2_rsdl_70F_hoo	-39.4702	-30.1753	145.503	-64.3057	StressDist
P3_rsdl_70F_hoo	-42.8367	-48.9998	154.565	-62.0792	StressDist
P1_rsdl_551F_ho	-30.5175	11.0008	90.953	-50.9343	StressDist
P2_rsdl_551F_ho	-32.6415	1.43969	105.477	-53.8	StressDist
P3_rsdl_551F_ho	-34.3878	-24.6287	118.724	-52.269	StressDist
primary hoop st	7.371	0	0	0	Coeff

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

Wall Depth	Case primary ho
0.0000	7.371
0.1220	7.371
0.2440	7.371
0.3660	7.371
0.4880	7.371
0.6100	7.371
0.7320	7.371
0.8540	7.371
0.9760	7.371
1.0980	7.371
1.2200	7.371

Crack Model: Elliptical Longitudinal Crack in Cylinder (t/R=0.1,a/l=0.1)

WARNING: The stress intensity factor (K) is the maximum of
K at the surface and K at the deepest point at each crack depth.

Crack Parameters:
Wall thickness: 1.6288
Max. crack size: 1.2200

Crack Size	Stress Intensity Factor Case P1_rsdl_70	Case P2_rsdl_70	Case P3_rsdl_70	Case P1_rsdl_55	Case P2_rsdl_55
0.0244	-6.71806	-6.22218	-6.76032	-4.79525	-5.13368
0.0488	-9.48828	-8.80282	-9.57471	-6.76207	-7.24594
0.0732	-11.6043	-10.784	-11.7426	-8.25709	-8.85602
0.0976	-13.3793	-12.4539	-13.5761	-9.50485	-10.2036
0.1220	-14.9344	-13.9239	-15.1956	-10.5924	-11.3814
0.1464	-16.3317	-15.2508	-16.6625	-11.5643	-12.4371
0.1708	-17.6407	-16.4992	-18.0472	-12.4699	-13.4234
0.1952	-18.9295	-17.7332	-19.4205	-13.3569	-14.392
0.2196	-20.1503	-18.907	-20.7315	-14.1919	-15.3066
0.2440	-21.3137	-20.0303	-21.9907	-14.9827	-16.1754
0.2684	-22.4279	-21.1103	-23.2059	-15.735	-17.0044
0.2928	-23.4987	-22.1523	-24.3829	-16.4531	-17.7981
0.3172	-24.5309	-23.1605	-25.5263	-17.1404	-18.5602
0.3416	-25.6197	-24.2264	-26.7386	-17.8612	-19.3613
0.3660	-26.7332	-25.3196	-27.9863	-18.5937	-20.1775
0.3904	-27.8254	-26.3954	-29.2194	-19.3064	-20.9742
0.4148	-28.8976	-27.455	-30.439	-20.0001	-21.7524
0.4392	-29.9508	-28.4989	-31.6459	-20.6755	-22.5126
0.4636	-30.9857	-29.5277	-32.8407	-21.333	-23.2553
0.4880	-32.0029	-30.5417	-34.0238	-21.973	-23.9809
0.5124	-33.1651	-31.7001	-35.3773	-22.7021	-24.808
0.5368	-34.3204	-32.8544	-36.7324	-23.4195	-25.6248
0.5612	-35.4642	-34.0000	-38.0839	-24.1222	-26.4279
0.5856	-36.5961	-35.1362	-39.4311	-24.8097	-27.2167
0.6100	-37.7156	-36.2624	-40.7733	-25.4817	-27.9908
0.6344	-38.8222	-37.3778	-42.1099	-26.1377	-28.7496
0.6588	-39.9702	-38.536	-43.5031	-26.812	-29.5319
0.6832	-41.236	-39.813	-45.0418	-26.6359	-30.3916
0.7076	-42.4914	-41.0815	-46.579	-26.054	-31.2364
0.7320	-43.7352	-42.3404	-48.1134	-25.3891	-31.7379
0.7564	-44.9667	-43.5886	-49.6438	-24.6421	-31.0844
0.7808	-46.1849	-44.8248	-51.1689	-23.8134	-30.3369
0.8052	-47.3889	-46.048	-52.6876	-22.9039	-29.4957
0.8296	-48.6983	-47.3774	-54.3414	-21.974	-28.6297
0.8540	-50.0665	-48.7665	-56.0763	-21.0074	-27.719
0.8784	-51.4199	-50.1416	-57.8054	-19.9712	-26.7251
0.9028	-52.7572	-51.5014	-59.527	-18.8676	-25.6496
0.9272	-53.1925	-52.8443	-61.2397	-17.6986	-24.4942
0.9516	-52.6735	-53.0186	-62.942	-16.4669	-23.261
0.9760	-52.0769	-52.2251	-64.6325	-15.1748	-21.952

1.0004	-51.6976	-51.6365	-66.5355	-14.0253	-20.7907
1.0248	-51.2794	-50.9895	-68.4384	-12.847	-19.5863
1.0492	-50.8105	-50.2715	-70.3271	-11.6338	-18.331
1.0736	-50.295	-49.4867	-72.1998	-10.3904	-17.0293
1.0980	-49.7375	-48.6393	-74.0551	-9.12204	-15.6858
1.1224	-49.1428	-47.7339	-75.8777	-7.83391	-14.3055
1.1468	-48.5185	-46.7905	-75.5827	-6.53329	-12.8971
1.1712	-47.8864	-45.8538	-75.2889	-5.23966	-11.4835
1.1956	-47.2532	-44.8991	-74.9613	-3.96252	-10.0689
1.2200	-46.6274	-43.935	-74.6071	-2.71053	-8.66168

----------Stress Intensity Factor----------

Crack Size	Case P3_rsdl_55	Case primary ho
0.0244	-5.42025	1.92366
0.0488	-7.6673	2.74502
0.0732	-9.39176	3.39203
0.0976	-10.8449	3.9515
0.1220	-12.1237	4.45674
0.1464	-13.2777	4.92465
0.1708	-14.3633	5.36888
0.1952	-15.4364	5.80088
0.2196	-16.4569	6.21779
0.2440	-17.4335	6.62266
0.2684	-18.3725	7.0178
0.2928	-19.2785	7.40494
0.3172	-20.1552	7.78545
0.3416	-21.0823	8.17085
0.3660	-22.0333	8.55815
0.3904	-22.9696	8.94264
0.4148	-23.8919	9.32488
0.4392	-24.8009	9.70534
0.4636	-25.6973	10.0844
0.4880	-26.5812	10.4625
0.5124	-27.5913	10.859
0.5368	-28.5985	11.2565
0.5612	-29.5988	11.6547
0.5856	-30.5916	12.0536
0.6100	-31.5764	12.4535
0.6344	-32.5526	12.8544
0.6588	-33.5671	13.2633
0.6832	-34.6861	13.6898
0.7076	-35.7989	14.1185

0.7320	-36.9044	14.5494
0.7564	-38.0017	14.9826
0.7808	-39.0899	15.4181
0.8052	-40.1681	15.856
0.8296	-41.3407	16.3116
0.8540	-42.5671	16.7796
0.8784	-43.7829	17.2508
0.9028	-44.9871	17.7251
0.9272	-46.1785	18.2026
0.9516	-47.3561	18.6832
0.9760	-48.1482	19.167
1.0004	-47.8113	19.6987
1.0248	-47.4277	20.2373
1.0492	-46.9864	20.7801
1.0736	-46.4907	21.3272
1.0980	-45.944	21.8785
1.1224	-45.3499	22.4339
1.1468	-44.7235	22.9901
1.1712	-44.099	23.5412
1.1956	-43.4594	24.0961
1.2200	-42.8116	24.6548

Crack Growth Laws:

Law ID: IGSCC_HWC
Type: Corrosion
Model: Paris

da/dN = c * (dK)^n
where
dK = Kmax - Kmin
dK > Kthres
Kmax < K1c

Material parameters:
c = 3.2000e-010
n = 3.0000
Kthres = 0.0000

Material Fracture Toughness KIc:

Material ID: Alloy 82/182

Depth	KIc
0.0000	63.2500
0.7500	63.2500
1.5000	63.2500

Material ID: high toughness

Depth	KIc
0.0000	200.0000
0.7500	200.0000
1.5000	200.0000

Initial crack size= 0.5100
Max. crack size= 1.2200

Number of blocks= 1
Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
growth	175200	20	1000	IGSCC_HWC	Alloy 82/182

Subblock	Kmax Case ID	Kmax Scale Factor	Kmin Case ID	Kmin Scale Factor
growth	primary hoop stress	1.0000		

Crack growth results:

Total Cycles /Time	Subblock Cycles /Time	Kmax	Kmin	DeltaK	R	DaDn /DaDt	Da	a	a/thk
Block: 1									
1000	1000	1.08e+001	0.00e+000	1.08e+001	0.00	4.06e-007	8.12e-006	0.5104	0.31
2000	2000	1.08e+001	0.00e+000	1.08e+001	0.00	4.07e-007	8.14e-006	0.5108	0.31
3000	3000	1.08e+001	0.00e+000	1.08e+001	0.00	4.08e-007	8.15e-006	0.5112	0.31
4000	4000	1.08e+001	0.00e+000	1.08e+001	0.00	4.08e-007	8.17e-006	0.5116	0.31

5000	5000	1.09e+001	0.00e+000	1.09e+001	0.00	4.09e-007	8.18e-006	0.512	0.31
6000	6000	1.09e+001	0.00e+000	1.09e+001	0.00	4.10e-007	8.20e-006	0.5124	0.31
7000	7000	1.09e+001	0.00e+000	1.09e+001	0.00	4.11e-007	8.21e-006	0.5129	0.31
8000	8000	1.09e+001	0.00e+000	1.09e+001	0.00	4.11e-007	8.23e-006	0.5133	0.32
9000	9000	1.09e+001	0.00e+000	1.09e+001	0.00	4.12e-007	8.24e-006	0.5137	0.32
10000	10000	1.09e+001	0.00e+000	1.09e+001	0.00	4.13e-007	8.26e-006	0.5141	0.32
11000	11000	1.09e+001	0.00e+000	1.09e+001	0.00	4.14e-007	8.27e-006	0.5145	0.32
12000	12000	1.09e+001	0.00e+000	1.09e+001	0.00	4.14e-007	8.29e-006	0.5149	0.32
13000	13000	1.09e+001	0.00e+000	1.09e+001	0.00	4.15e-007	8.30e-006	0.5153	0.32
14000	14000	1.09e+001	0.00e+000	1.09e+001	0.00	4.16e-007	8.32e-006	0.5157	0.32
15000	15000	1.09e+001	0.00e+000	1.09e+001	0.00	4.17e-007	8.33e-006	0.5162	0.32
16000	16000	1.09e+001	0.00e+000	1.09e+001	0.00	4.17e-007	8.35e-006	0.5166	0.32
17000	17000	1.09e+001	0.00e+000	1.09e+001	0.00	4.18e-007	8.37e-006	0.517	0.32
18000	18000	1.09e+001	0.00e+000	1.09e+001	0.00	4.19e-007	8.38e-006	0.5174	0.32
19000	19000	1.09e+001	0.00e+000	1.09e+001	0.00	4.20e-007	8.40e-006	0.5178	0.32
20000	20000	1.10e+001	0.00e+000	1.10e+001	0.00	4.21e-007	8.41e-006	0.5183	0.32
21000	21000	1.10e+001	0.00e+000	1.10e+001	0.00	4.21e-007	8.43e-006	0.5187	0.32
22000	22000	1.10e+001	0.00e+000	1.10e+001	0.00	4.22e-007	8.44e-006	0.5191	0.32
23000	23000	1.10e+001	0.00e+000	1.10e+001	0.00	4.23e-007	8.46e-006	0.5195	0.32
24000	24000	1.10e+001	0.00e+000	1.10e+001	0.00	4.24e-007	8.48e-006	0.5199	0.32
25000	25000	1.10e+001	0.00e+000	1.10e+001	0.00	4.25e-007	8.49e-006	0.5204	0.32
26000	26000	1.10e+001	0.00e+000	1.10e+001	0.00	4.25e-007	8.51e-006	0.5208	0.32
27000	27000	1.10e+001	0.00e+000	1.10e+001	0.00	4.26e-007	8.52e-006	0.5212	0.32
28000	28000	1.10e+001	0.00e+000	1.10e+001	0.00	4.27e-007	8.54e-006	0.5216	0.32
29000	29000	1.10e+001	0.00e+000	1.10e+001	0.00	4.28e-007	8.56e-006	0.5221	0.32
30000	30000	1.10e+001	0.00e+000	1.10e+001	0.00	4.29e-007	8.57e-006	0.5225	0.32
31000	31000	1.10e+001	0.00e+000	1.10e+001	0.00	4.29e-007	8.59e-006	0.5229	0.32
32000	32000	1.10e+001	0.00e+000	1.10e+001	0.00	4.30e-007	8.61e-006	0.5234	0.32
33000	33000	1.10e+001	0.00e+000	1.10e+001	0.00	4.31e-007	8.62e-006	0.5238	0.32
34000	34000	1.11e+001	0.00e+000	1.11e+001	0.00	4.32e-007	8.64e-006	0.5242	0.32
35000	35000	1.11e+001	0.00e+000	1.11e+001	0.00	4.33e-007	8.66e-006	0.5247	0.32
36000	36000	1.11e+001	0.00e+000	1.11e+001	0.00	4.34e-007	8.67e-006	0.5251	0.32
37000	37000	1.11e+001	0.00e+000	1.11e+001	0.00	4.34e-007	8.69e-006	0.5255	0.32
38000	38000	1.11e+001	0.00e+000	1.11e+001	0.00	4.35e-007	8.71e-006	0.526	0.32
39000	39000	1.11e+001	0.00e+000	1.11e+001	0.00	4.36e-007	8.72e-006	0.5264	0.32
40000	40000	1.11e+001	0.00e+000	1.11e+001	0.00	4.37e-007	8.74e-006	0.5268	0.32
41000	41000	1.11e+001	0.00e+000	1.11e+001	0.00	4.38e-007	8.76e-006	0.5273	0.32
42000	42000	1.11e+001	0.00e+000	1.11e+001	0.00	4.39e-007	8.77e-006	0.5277	0.32
43000	43000	1.11e+001	0.00e+000	1.11e+001	0.00	4.39e-007	8.79e-006	0.5281	0.32
44000	44000	1.11e+001	0.00e+000	1.11e+001	0.00	4.40e-007	8.81e-006	0.5286	0.32
45000	45000	1.11e+001	0.00e+000	1.11e+001	0.00	4.41e-007	8.82e-006	0.529	0.32
46000	46000	1.11e+001	0.00e+000	1.11e+001	0.00	4.42e-007	8.84e-006	0.5295	0.33
47000	47000	1.11e+001	0.00e+000	1.11e+001	0.00	4.43e-007	8.86e-006	0.5299	0.33
48000	48000	1.12e+001	0.00e+000	1.12e+001	0.00	4.44e-007	8.87e-006	0.5304	0.33
49000	49000	1.12e+001	0.00e+000	1.12e+001	0.00	4.45e-007	8.89e-006	0.5308	0.33

50000	50000	1.12e+001	0.00e+000	1.12e+001	0.00	4.45e-007	8.91e-006	0.5312	0.33
51000	51000	1.12e+001	0.00e+000	1.12e+001	0.00	4.46e-007	8.93e-006	0.5317	0.33
52000	52000	1.12e+001	0.00e+000	1.12e+001	0.00	4.47e-007	8.94e-006	0.5321	0.33
53000	53000	1.12e+001	0.00e+000	1.12e+001	0.00	4.48e-007	8.96e-006	0.5326	0.33
54000	54000	1.12e+001	0.00e+000	1.12e+001	0.00	4.49e-007	8.98e-006	0.533	0.33
55000	55000	1.12e+001	0.00e+000	1.12e+001	0.00	4.50e-007	9.00e-006	0.5335	0.33
56000	56000	1.12e+001	0.00e+000	1.12e+001	0.00	4.51e-007	9.01e-006	0.5339	0.33
57000	57000	1.12e+001	0.00e+000	1.12e+001	0.00	4.52e-007	9.03e-006	0.5344	0.33
58000	58000	1.12e+001	0.00e+000	1.12e+001	0.00	4.53e-007	9.05e-006	0.5348	0.33
59000	59000	1.12e+001	0.00e+000	1.12e+001	0.00	4.53e-007	9.07e-006	0.5353	0.33
60000	60000	1.12e+001	0.00e+000	1.12e+001	0.00	4.54e-007	9.09e-006	0.5357	0.33
61000	61000	1.12e+001	0.00e+000	1.12e+001	0.00	4.55e-007	9.10e-006	0.5362	0.33
62000	62000	1.13e+001	0.00e+000	1.13e+001	0.00	4.56e-007	9.12e-006	0.5367	0.33
63000	63000	1.13e+001	0.00e+000	1.13e+001	0.00	4.57e-007	9.14e-006	0.5371	0.33
64000	64000	1.13e+001	0.00e+000	1.13e+001	0.00	4.58e-007	9.16e-006	0.5376	0.33
65000	65000	1.13e+001	0.00e+000	1.13e+001	0.00	4.59e-007	9.18e-006	0.538	0.33
66000	66000	1.13e+001	0.00e+000	1.13e+001	0.00	4.60e-007	9.20e-006	0.5385	0.33
67000	67000	1.13e+001	0.00e+000	1.13e+001	0.00	4.61e-007	9.21e-006	0.5389	0.33
68000	68000	1.13e+001	0.00e+000	1.13e+001	0.00	4.62e-007	9.23e-006	0.5394	0.33
69000	69000	1.13e+001	0.00e+000	1.13e+001	0.00	4.63e-007	9.25e-006	0.5399	0.33
70000	70000	1.13e+001	0.00e+000	1.13e+001	0.00	4.63e-007	9.27e-006	0.5403	0.33
71000	71000	1.13e+001	0.00e+000	1.13e+001	0.00	4.64e-007	9.29e-006	0.5408	0.33
72000	72000	1.13e+001	0.00e+000	1.13e+001	0.00	4.65e-007	9.31e-006	0.5413	0.33
73000	73000	1.13e+001	0.00e+000	1.13e+001	0.00	4.66e-007	9.32e-006	0.5417	0.33
74000	74000	1.13e+001	0.00e+000	1.13e+001	0.00	4.67e-007	9.34e-006	0.5422	0.33
75000	75000	1.14e+001	0.00e+000	1.14e+001	0.00	4.68e-007	9.36e-006	0.5427	0.33
76000	76000	1.14e+001	0.00e+000	1.14e+001	0.00	4.69e-007	9.38e-006	0.5431	0.33
77000	77000	1.14e+001	0.00e+000	1.14e+001	0.00	4.70e-007	9.40e-006	0.5436	0.33
78000	78000	1.14e+001	0.00e+000	1.14e+001	0.00	4.71e-007	9.42e-006	0.5441	0.33
79000	79000	1.14e+001	0.00e+000	1.14e+001	0.00	4.72e-007	9.44e-006	0.5445	0.33
80000	80000	1.14e+001	0.00e+000	1.14e+001	0.00	4.73e-007	9.46e-006	0.545	0.33
81000	81000	1.14e+001	0.00e+000	1.14e+001	0.00	4.74e-007	9.48e-006	0.5455	0.33
82000	82000	1.14e+001	0.00e+000	1.14e+001	0.00	4.75e-007	9.50e-006	0.546	0.34
83000	83000	1.14e+001	0.00e+000	1.14e+001	0.00	4.76e-007	9.52e-006	0.5464	0.34
84000	84000	1.14e+001	0.00e+000	1.14e+001	0.00	4.77e-007	9.54e-006	0.5469	0.34
85000	85000	1.14e+001	0.00e+000	1.14e+001	0.00	4.78e-007	9.55e-006	0.5474	0.34
86000	86000	1.14e+001	0.00e+000	1.14e+001	0.00	4.79e-007	9.57e-006	0.5479	0.34
87000	87000	1.14e+001	0.00e+000	1.14e+001	0.00	4.80e-007	9.59e-006	0.5483	0.34
88000	88000	1.15e+001	0.00e+000	1.15e+001	0.00	4.81e-007	9.61e-006	0.5488	0.34
89000	89000	1.15e+001	0.00e+000	1.15e+001	0.00	4.82e-007	9.63e-006	0.5493	0.34
90000	90000	1.15e+001	0.00e+000	1.15e+001	0.00	4.83e-007	9.65e-006	0.5498	0.34
91000	91000	1.15e+001	0.00e+000	1.15e+001	0.00	4.84e-007	9.67e-006	0.5503	0.34
92000	92000	1.15e+001	0.00e+000	1.15e+001	0.00	4.85e-007	9.69e-006	0.5508	0.34
93000	93000	1.15e+001	0.00e+000	1.15e+001	0.00	4.86e-007	9.71e-006	0.5512	0.34
94000	94000	1.15e+001	0.00e+000	1.15e+001	0.00	4.87e-007	9.73e-006	0.5517	0.34

95000	95000	1.15e+001	0.00e+000	1.15e+001	0.00	4.88e-007	9.75e-006	0.5522	0.34
96000	96000	1.15e+001	0.00e+000	1.15e+001	0.00	4.89e-007	9.77e-006	0.5527	0.34
97000	97000	1.15e+001	0.00e+000	1.15e+001	0.00	4.90e-007	9.79e-006	0.5532	0.34
98000	98000	1.15e+001	0.00e+000	1.15e+001	0.00	4.91e-007	9.81e-006	0.5537	0.34
99000	99000	1.15e+001	0.00e+000	1.15e+001	0.00	4.92e-007	9.84e-006	0.5542	0.34
100000	100000	1.15e+001	0.00e+000	1.15e+001	0.00	4.93e-007	9.86e-006	0.5547	0.34
101000	101000	1.16e+001	0.00e+000	1.16e+001	0.00	4.94e-007	9.88e-006	0.5552	0.34
102000	102000	1.16e+001	0.00e+000	1.16e+001	0.00	4.95e-007	9.90e-006	0.5557	0.34
103000	103000	1.16e+001	0.00e+000	1.16e+001	0.00	4.96e-007	9.92e-006	0.5561	0.34
104000	104000	1.16e+001	0.00e+000	1.16e+001	0.00	4.97e-007	9.94e-006	0.5566	0.34
105000	105000	1.16e+001	0.00e+000	1.16e+001	0.00	4.98e-007	9.96e-006	0.5571	0.34
106000	106000	1.16e+001	0.00e+000	1.16e+001	0.00	4.99e-007	9.98e-006	0.5576	0.34
107000	107000	1.16e+001	0.00e+000	1.16e+001	0.00	5.00e-007	1.00e-005	0.5581	0.34
108000	108000	1.16e+001	0.00e+000	1.16e+001	0.00	5.01e-007	1.00e-005	0.5586	0.34
109000	109000	1.16e+001	0.00e+000	1.16e+001	0.00	5.02e-007	1.00e-005	0.5591	0.34
110000	110000	1.16e+001	0.00e+000	1.16e+001	0.00	5.03e-007	1.01e-005	0.5596	0.34
111000	111000	1.16e+001	0.00e+000	1.16e+001	0.00	5.04e-007	1.01e-005	0.5602	0.34
112000	112000	1.16e+001	0.00e+000	1.16e+001	0.00	5.05e-007	1.01e-005	0.5607	0.34
113000	113000	1.17e+001	0.00e+000	1.17e+001	0.00	5.06e-007	1.01e-005	0.5612	0.34
114000	114000	1.17e+001	0.00e+000	1.17e+001	0.00	5.08e-007	1.02e-005	0.5617	0.34
115000	115000	1.17e+001	0.00e+000	1.17e+001	0.00	5.09e-007	1.02e-005	0.5622	0.35
116000	116000	1.17e+001	0.00e+000	1.17e+001	0.00	5.10e-007	1.02e-005	0.5627	0.35
117000	117000	1.17e+001	0.00e+000	1.17e+001	0.00	5.11e-007	1.02e-005	0.5632	0.35
118000	118000	1.17e+001	0.00e+000	1.17e+001	0.00	5.12e-007	1.02e-005	0.5637	0.35
119000	119000	1.17e+001	0.00e+000	1.17e+001	0.00	5.13e-007	1.03e-005	0.5642	0.35
120000	120000	1.17e+001	0.00e+000	1.17e+001	0.00	5.14e-007	1.03e-005	0.5647	0.35
121000	121000	1.17e+001	0.00e+000	1.17e+001	0.00	5.15e-007	1.03e-005	0.5652	0.35
122000	122000	1.17e+001	0.00e+000	1.17e+001	0.00	5.16e-007	1.03e-005	0.5658	0.35
123000	123000	1.17e+001	0.00e+000	1.17e+001	0.00	5.17e-007	1.03e-005	0.5663	0.35
124000	124000	1.17e+001	0.00e+000	1.17e+001	0.00	5.19e-007	1.04e-005	0.5668	0.35
125000	125000	1.18e+001	0.00e+000	1.18e+001	0.00	5.20e-007	1.04e-005	0.5673	0.35
126000	126000	1.18e+001	0.00e+000	1.18e+001	0.00	5.21e-007	1.04e-005	0.5678	0.35
127000	127000	1.18e+001	0.00e+000	1.18e+001	0.00	5.22e-007	1.04e-005	0.5684	0.35
128000	128000	1.18e+001	0.00e+000	1.18e+001	0.00	5.23e-007	1.05e-005	0.5689	0.35
129000	129000	1.18e+001	0.00e+000	1.18e+001	0.00	5.24e-007	1.05e-005	0.5694	0.35
130000	130000	1.18e+001	0.00e+000	1.18e+001	0.00	5.25e-007	1.05e-005	0.5699	0.35
131000	131000	1.18e+001	0.00e+000	1.18e+001	0.00	5.27e-007	1.05e-005	0.5705	0.35
132000	132000	1.18e+001	0.00e+000	1.18e+001	0.00	5.28e-007	1.06e-005	0.571	0.35
133000	133000	1.18e+001	0.00e+000	1.18e+001	0.00	5.29e-007	1.06e-005	0.5715	0.35
134000	134000	1.18e+001	0.00e+000	1.18e+001	0.00	5.30e-007	1.06e-005	0.572	0.35
135000	135000	1.18e+001	0.00e+000	1.18e+001	0.00	5.31e-007	1.06e-005	0.5726	0.35
136000	136000	1.18e+001	0.00e+000	1.18e+001	0.00	5.32e-007	1.06e-005	0.5731	0.35
137000	137000	1.19e+001	0.00e+000	1.19e+001	0.00	5.34e-007	1.07e-005	0.5736	0.35
138000	138000	1.19e+001	0.00e+000	1.19e+001	0.00	5.35e-007	1.07e-005	0.5742	0.35
139000	139000	1.19e+001	0.00e+000	1.19e+001	0.00	5.36e-007	1.07e-005	0.5747	0.35

140000	140000	1.19e+001	0.00e+000	1.19e+001	0.00	5.37e-007	1.07e-005	0.5752	0.35
141000	141000	1.19e+001	0.00e+000	1.19e+001	0.00	5.38e-007	1.08e-005	0.5758	0.35
142000	142000	1.19e+001	0.00e+000	1.19e+001	0.00	5.39e-007	1.08e-005	0.5763	0.35
143000	143000	1.19e+001	0.00e+000	1.19e+001	0.00	5.41e-007	1.08e-005	0.5769	0.35
144000	144000	1.19e+001	0.00e+000	1.19e+001	0.00	5.42e-007	1.08e-005	0.5774	0.35
145000	145000	1.19e+001	0.00e+000	1.19e+001	0.00	5.43e-007	1.09e-005	0.5779	0.35
146000	146000	1.19e+001	0.00e+000	1.19e+001	0.00	5.44e-007	1.09e-005	0.5785	0.36
147000	147000	1.19e+001	0.00e+000	1.19e+001	0.00	5.46e-007	1.09e-005	0.579	0.36
148000	148000	1.20e+001	0.00e+000	1.20e+001	0.00	5.47e-007	1.09e-005	0.5796	0.36
149000	149000	1.20e+001	0.00e+000	1.20e+001	0.00	5.48e-007	1.10e-005	0.5801	0.36
150000	150000	1.20e+001	0.00e+000	1.20e+001	0.00	5.49e-007	1.10e-005	0.5807	0.36
151000	151000	1.20e+001	0.00e+000	1.20e+001	0.00	5.50e-007	1.10e-005	0.5812	0.36
152000	152000	1.20e+001	0.00e+000	1.20e+001	0.00	5.52e-007	1.10e-005	0.5818	0.36
153000	153000	1.20e+001	0.00e+000	1.20e+001	0.00	5.53e-007	1.11e-005	0.5823	0.36
154000	154000	1.20e+001	0.00e+000	1.20e+001	0.00	5.54e-007	1.11e-005	0.5829	0.36
155000	155000	1.20e+001	0.00e+000	1.20e+001	0.00	5.55e-007	1.11e-005	0.5834	0.36
156000	156000	1.20e+001	0.00e+000	1.20e+001	0.00	5.57e-007	1.11e-005	0.584	0.36
157000	157000	1.20e+001	0.00e+000	1.20e+001	0.00	5.58e-007	1.12e-005	0.5846	0.36
158000	158000	1.20e+001	0.00e+000	1.20e+001	0.00	5.59e-007	1.12e-005	0.5851	0.36
159000	159000	1.21e+001	0.00e+000	1.21e+001	0.00	5.61e-007	1.12e-005	0.5857	0.36
160000	160000	1.21e+001	0.00e+000	1.21e+001	0.00	5.62e-007	1.12e-005	0.5862	0.36
161000	161000	1.21e+001	0.00e+000	1.21e+001	0.00	5.63e-007	1.13e-005	0.5868	0.36
162000	162000	1.21e+001	0.00e+000	1.21e+001	0.00	5.64e-007	1.13e-005	0.5874	0.36
163000	163000	1.21e+001	0.00e+000	1.21e+001	0.00	5.66e-007	1.13e-005	0.5879	0.36
164000	164000	1.21e+001	0.00e+000	1.21e+001	0.00	5.67e-007	1.13e-005	0.5885	0.36
165000	165000	1.21e+001	0.00e+000	1.21e+001	0.00	5.68e-007	1.14e-005	0.5891	0.36
166000	166000	1.21e+001	0.00e+000	1.21e+001	0.00	5.70e-007	1.14e-005	0.5896	0.36
167000	167000	1.21e+001	0.00e+000	1.21e+001	0.00	5.71e-007	1.14e-005	0.5902	0.36
168000	168000	1.21e+001	0.00e+000	1.21e+001	0.00	5.72e-007	1.14e-005	0.5908	0.36
169000	169000	1.21e+001	0.00e+000	1.21e+001	0.00	5.74e-007	1.15e-005	0.5913	0.36
170000	170000	1.22e+001	0.00e+000	1.22e+001	0.00	5.75e-007	1.15e-005	0.5919	0.36
171000	171000	1.22e+001	0.00e+000	1.22e+001	0.00	5.76e-007	1.15e-005	0.5925	0.36
172000	172000	1.22e+001	0.00e+000	1.22e+001	0.00	5.78e-007	1.16e-005	0.5931	0.36
173000	173000	1.22e+001	0.00e+000	1.22e+001	0.00	5.79e-007	1.16e-005	0.5936	0.36
174000	174000	1.22e+001	0.00e+000	1.22e+001	0.00	5.80e-007	1.16e-005	0.5942	0.36
175000	175000	1.22e+001	0.00e+000	1.22e+001	0.00	5.82e-007	1.16e-005	0.5948	0.37
175200	175200	1.22e+001	0.00e+000	1.22e+001	0.00	5.82e-007	1.16e-005	0.5949	0.37

End of pc-CRACK Output

Output for FCG case without residual stresses:

tm
pc-CRACK for Windows
Version 3.1-98348
(C) Copyright '84 - '98
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: Mon Dec 01 15:14:06 2008
Input Data and Results File: N2.LFM

Title: JAF N2 Crack Growth Without Residual Stresses

Load Cases:

Case ID: P1_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-39.7170
0.0793	-40.3490
0.1587	-40.7120
0.2380	-40.9920
0.3173	-40.0580
0.3967	-36.4000
0.4760	-30.3220
0.5553	-22.7690
0.6347	-12.5050
0.7140	-1.5176
0.7933	3.8362
0.8727	6.5966
0.9520	8.8339
1.0313	10.6030
1.1107	11.4380
1.1900	11.8810
1.2693	13.8740

1.3487	17.0970
1.4280	18.6230
1.5073	18.0990
1.5867	15.5500

Case ID: P2_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-40.6750
0.0792	-38.7950
0.1584	-36.3090
0.2376	-35.6780
0.3168	-38.8330
0.3960	-33.5040
0.4752	-39.3260
0.5544	-36.5530
0.6336	-21.1880
0.7128	-4.6270
0.7920	9.1298
0.8712	15.3010
0.9503	16.8200
1.0295	16.7900
1.1087	15.8530
1.1879	14.3480
1.2671	15.4520
1.3463	20.0010
1.4255	24.3720
1.5047	27.8520
1.5839	29.3440

Case ID: P3_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-38.4610
0.0853	-39.5790
0.1707	-49.1040
0.2560	-51.6050
0.3413	-51.2820
0.4266	-47.4160
0.5120	-41.6810
0.5973	-32.7260
0.6826	-20.8590
0.7679	-9.6705

0.8533	-0.2673
0.9386	7.0081
1.0239	8.3770
1.1093	9.4758
1.1946	9.1873
1.2799	9.0162
1.3652	11.2680
1.4506	15.8210
1.5359	18.7370
1.6212	21.4980
1.7065	23.6410

Case ID: P1_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-26.5210
0.0793	-26.9270
0.1587	-26.9240
0.2380	-26.3780
0.3173	-24.6910
0.3967	-20.6710
0.4760	-14.6190
0.5553	-7.2662
0.6347	2.3816
0.7140	12.6720
0.7933	17.6200
0.8727	20.1090
0.9520	22.0400
1.0313	23.5030
1.1107	22.1790
1.1900	20.0260
1.2693	17.4550
1.3487	20.1960
1.4280	21.3010
1.5073	20.4310
1.5867	17.8390

Case ID: P2_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-32.6410
0.0792	-30.4050
0.1584	-26.2400

0.2376	-23.6480
0.3168	-25.6030
0.3960	-20.0130
0.4752	-25.0810
0.5544	-22.2480
0.6336	-7.8169
0.7128	7.6241
0.7920	20.3840
0.8712	26.0170
0.9503	27.2700
1.0295	27.0450
1.1087	24.8660
1.1879	20.2130
1.2671	16.8180
1.3463	20.8460
1.4255	24.6800
1.5047	27.6550
1.5839	28.8950

Case ID: P3_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-29.0710
0.0853	-31.1390
0.1707	-37.1380
0.2560	-38.5510
0.3413	-37.6290
0.4266	-34.0970
0.5120	-29.0900
0.5973	-20.9770
0.6826	-10.0800
0.7679	0.1012
0.8533	8.4945
0.9386	14.8890
1.0239	15.7350
1.1093	16.1220
1.1946	13.6400
1.2799	11.2460
1.3652	8.7844
1.4506	12.6900
1.5359	15.0840
1.6212	17.3120
1.7065	19.0350

Case ID	Stress Coefficients C0	C1	C2	C3	Type
P1_rsdl_70F_hoo	-42.6891	-7.07378	115.185	-56.0956	StressDist
P2_rsdl_70F_hoo	-39.4702	-30.1753	145.503	-64.3057	StressDist
P3_rsdl_70F_hoo	-42.8367	-48.9998	154.565	-62.0792	StressDist
P1_rsdl_551F_ho	-30.5175	11.0008	90.953	-50.9343	StressDist
P2_rsdl_551F_ho	-32.6415	1.43969	105.477	-53.8	StressDist
P3_rsdl_551F_ho	-34.3878	-24.6287	118.724	-52.269	StressDist
primary hoop st	7.371	0	0	0	Coeff

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

Wall Depth	Case primary ho
0.0000	7.371
0.1220	7.371
0.2440	7.371
0.3660	7.371
0.4880	7.371
0.6100	7.371
0.7320	7.371
0.8540	7.371
0.9760	7.371
1.0980	7.371
1.2200	7.371

Crack Model: Elliptical Longitudinal Crack in Cylinder (t/R=0.1,a/l=0.1)

WARNING: The stress intensity factor (K) is the maximum of
K at the surface and K at the deepest point at each crack depth.

Crack Parameters:
Wall thickness: 1.6288
Max. crack size: 1.2200

----------Stress Intensity Factor----------

Crack Size	Case P1_rsdl_70	Case P2_rsdl_70	Case P3_rsdl_70	Case P1_rsdl_55	Case P2_rsdl_55

0.0244	-6.71806	-6.22218	-6.76032	-4.79525	-5.13368
0.0488	-9.48828	-8.80282	-9.57471	-6.76207	-7.24594
0.0732	-11.6043	-10.784	-11.7426	-8.25709	-8.85602
0.0976	-13.3793	-12.4539	-13.5761	-9.50485	-10.2036
0.1220	-14.9344	-13.9239	-15.1956	-10.5924	-11.3814
0.1464	-16.3317	-15.2508	-16.6625	-11.5643	-12.4371
0.1708	-17.6407	-16.4992	-18.0472	-12.4699	-13.4234
0.1952	-18.9295	-17.7332	-19.4205	-13.3569	-14.392
0.2196	-20.1503	-18.907	-20.7315	-14.1919	-15.3066
0.2440	-21.3137	-20.0303	-21.9907	-14.9827	-16.1754
0.2684	-22.4279	-21.1103	-23.2059	-15.735	-17.0044
0.2928	-23.4987	-22.1523	-24.3829	-16.4531	-17.7981
0.3172	-24.5309	-23.1605	-25.5263	-17.1404	-18.5602
0.3416	-25.6197	-24.2264	-26.7386	-17.8612	-19.3613
0.3660	-26.7332	-25.3196	-27.9863	-18.5937	-20.1775
0.3904	-27.8254	-26.3954	-29.2194	-19.3064	-20.9742
0.4148	-28.8976	-27.455	-30.439	-20.0001	-21.7524
0.4392	-29.9508	-28.4989	-31.6459	-20.6755	-22.5126
0.4636	-30.9857	-29.5277	-32.8407	-21.333	-23.2553
0.4880	-32.0029	-30.5417	-34.0238	-21.973	-23.9809
0.5124	-33.1651	-31.7001	-35.3773	-22.7021	-24.808
0.5368	-34.3204	-32.8544	-36.7324	-23.4195	-25.6248
0.5612	-35.4642	-34	-38.0839	-24.1222	-26.4279
0.5856	-36.5961	-35.1362	-39.4311	-24.8097	-27.2167
0.6100	-37.7156	-36.2624	-40.7733	-25.4817	-27.9908
0.6344	-38.8222	-37.3778	-42.1099	-26.1377	-28.7496
0.6588	-39.9702	-38.536	-43.5031	-26.812	-29.5319
0.6832	-41.236	-39.813	-45.0418	-26.6359	-30.3916
0.7076	-42.4914	-41.0815	-46.579	-26.054	-31.2364
0.7320	-43.7352	-42.3404	-48.1134	-25.3891	-31.7379
0.7564	-44.9667	-43.5886	-49.6438	-24.6421	-31.0844
0.7808	-46.1849	-44.8248	-51.1689	-23.8134	-30.3369
0.8052	-47.3889	-46.048	-52.6876	-22.9039	-29.4957
0.8296	-48.6983	-47.3774	-54.3414	-21.974	-28.6297
0.8540	-50.0665	-48.7665	-56.0763	-21.0074	-27.719
0.8784	-51.4199	-50.1416	-57.8054	-19.9712	-26.7251
0.9028	-52.7572	-51.5014	-59.527	-18.8676	-25.6496
0.9272	-53.1925	-52.8443	-61.2397	-17.6986	-24.4942
0.9516	-52.6735	-53.0186	-62.942	-16.4669	-23.261
0.9760	-52.0769	-52.2251	-64.6325	-15.1748	-21.952
1.0004	-51.6976	-51.6365	-66.5355	-14.0253	-20.7907
1.0248	-51.2794	-50.9895	-68.4384	-12.847	-19.5863
1.0492	-50.8105	-50.2715	-70.3271	-11.6338	-18.331
1.0736	-50.295	-49.4867	-72.1998	-10.3904	-17.0293
1.0980	-49.7375	-48.6393	-74.0551	-9.12204	-15.6858

1.1224	-49.1428	-47.7339	-75.8777	-7.83391	-14.3055
1.1468	-48.5185	-46.7905	-75.5827	-6.53329	-12.8971
1.1712	-47.8864	-45.8538	-75.2889	-5.23966	-11.4835
1.1956	-47.2532	-44.8991	-74.9613	-3.96252	-10.0689
1.2200	-46.6274	-43.935	-74.6071	-2.71053	-8.66168

----------Stress Intensity Factor----------

Crack Size	Case P3_rsdl_55	Case primary ho
0.0244	-5.42025	1.92366
0.0488	-7.6673	2.74502
0.0732	-9.39176	3.39203
0.0976	-10.8449	3.9515
0.1220	-12.1237	4.45674
0.1464	-13.2777	4.92465
0.1708	-14.3633	5.36888
0.1952	-15.4364	5.80088
0.2196	-16.4569	6.21779
0.2440	-17.4335	6.62266
0.2684	-18.3725	7.0178
0.2928	-19.2785	7.40494
0.3172	-20.1552	7.78545
0.3416	-21.0823	8.17085
0.3660	-22.0333	8.55815
0.3904	-22.9696	8.94264
0.4148	-23.8919	9.32488
0.4392	-24.8009	9.70534
0.4636	-25.6973	10.0844
0.4880	-26.5812	10.4625
0.5124	-27.5913	10.859
0.5368	-28.5985	11.2565
0.5612	-29.5988	11.6547
0.5856	-30.5916	12.0536
0.6100	-31.5764	12.4535
0.6344	-32.5526	12.8544
0.6588	-33.5671	13.2633
0.6832	-34.6861	13.6898
0.7076	-35.7989	14.1185
0.7320	-36.9044	14.5494
0.7564	-38.0017	14.9826
0.7808	-39.0899	15.4181
0.8052	-40.1681	15.856
0.8296	-41.3407	16.3116

0.8540	-42.5671	16.7796
0.8784	-43.7829	17.2508
0.9028	-44.9871	17.7251
0.9272	-46.1785	18.2026
0.9516	-47.3561	18.6832
0.9760	-48.1482	19.167
1.0004	-47.8113	19.6987
1.0248	-47.4277	20.2373
1.0492	-46.9864	20.7801
1.0736	-46.4907	21.3272
1.0980	-45.944	21.8785
1.1224	-45.3499	22.4339
1.1468	-44.7235	22.9901
1.1712	-44.099	23.5412
1.1956	-43.4594	24.0961
1.2200	-42.8116	24.6548

Crack Growth Laws:

Law ID: Fatigue_551
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 = 1.8424e-010
is for the currently selected units of:
force: kip
length: inch
temperature: 551.0000 Fahrenheit

Material Fracture Toughness KIc:

Material ID: Alloy 82/182

Depth	KIc
0.0000	63.2500
0.7500	63.2500
1.5000	63.2500

Material ID: high toughness

Depth	KIc
0.0000	200.0000
0.7500	200.0000
1.5000	200.0000

Initial crack size= 0.5100
Max. crack size= 1.2200

Number of blocks= 1
Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
growth	10000	10	100	Fatigue_551	Alloy 82/182

Subblock	Kmax Case ID	Kmax Scale Factor	Kmin Case ID	Kmin Scale Factor
growth	primary hoop stress	1.0000		

Crack growth results:

Total Cycles /Time	Subblock Cycles /Time	Kmax	Kmin	DeltaK	R	DaDn /DaDt	Da	a	a/thk
Block: 1									
100	100	1.08e+001	0.00e+000	1.08e+001	0.00	4.77e-007	4.77e-006	0.51	0.31
200	200	1.08e+001	0.00e+000	1.08e+001	0.00	4.77e-007	4.77e-006	0.5101	0.31
300	300	1.08e+001	0.00e+000	1.08e+001	0.00	4.77e-007	4.77e-006	0.5101	0.31
400	400	1.08e+001	0.00e+000	1.08e+001	0.00	4.77e-007	4.77e-006	0.5102	0.31

500	500	1.08e+001	0.00e+000	1.08e+001	0.00	4.77e-007	4.77e-006	0.5102	0.31
600	600	1.08e+001	0.00e+000	1.08e+001	0.00	4.77e-007	4.77e-006	0.5103	0.31
700	700	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5103	0.31
800	800	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5104	0.31
900	900	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5104	0.31
1000	1000	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5105	0.31
1100	1100	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5105	0.31
1200	1200	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5106	0.31
1300	1300	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5106	0.31
1400	1400	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5107	0.31
1500	1500	1.08e+001	0.00e+000	1.08e+001	0.00	4.78e-007	4.78e-006	0.5107	0.31
1600	1600	1.08e+001	0.00e+000	1.08e+001	0.00	4.79e-007	4.79e-006	0.5108	0.31
1700	1700	1.08e+001	0.00e+000	1.08e+001	0.00	4.79e-007	4.79e-006	0.5108	0.31
1800	1800	1.08e+001	0.00e+000	1.08e+001	0.00	4.79e-007	4.79e-006	0.5109	0.31
1900	1900	1.08e+001	0.00e+000	1.08e+001	0.00	4.79e-007	4.79e-006	0.5109	0.31
2000	2000	1.08e+001	0.00e+000	1.08e+001	0.00	4.79e-007	4.79e-006	0.511	0.31
2100	2100	1.08e+001	0.00e+000	1.08e+001	0.00	4.79e-007	4.79e-006	0.511	0.31
2200	2200	1.08e+001	0.00e+000	1.08e+001	0.00	4.79e-007	4.79e-006	0.511	0.31
2300	2300	1.08e+001	0.00e+000	1.08e+001	0.00	4.79e-007	4.79e-006	0.5111	0.31
2400	2400	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5111	0.31
2500	2500	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5112	0.31
2600	2600	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5112	0.31
2700	2700	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5113	0.31
2800	2800	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5113	0.31
2900	2900	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5114	0.31
3000	3000	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5114	0.31
3100	3100	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5115	0.31
3200	3200	1.08e+001	0.00e+000	1.08e+001	0.00	4.80e-007	4.80e-006	0.5115	0.31
3300	3300	1.08e+001	0.00e+000	1.08e+001	0.00	4.81e-007	4.81e-006	0.5116	0.31
3400	3400	1.08e+001	0.00e+000	1.08e+001	0.00	4.81e-007	4.81e-006	0.5116	0.31
3500	3500	1.08e+001	0.00e+000	1.08e+001	0.00	4.81e-007	4.81e-006	0.5117	0.31
3600	3600	1.08e+001	0.00e+000	1.08e+001	0.00	4.81e-007	4.81e-006	0.5117	0.31
3700	3700	1.08e+001	0.00e+000	1.08e+001	0.00	4.81e-007	4.81e-006	0.5118	0.31
3800	3800	1.08e+001	0.00e+000	1.08e+001	0.00	4.81e-007	4.81e-006	0.5118	0.31
3900	3900	1.09e+001	0.00e+000	1.09e+001	0.00	4.81e-007	4.81e-006	0.5119	0.31
4000	4000	1.09e+001	0.00e+000	1.09e+001	0.00	4.81e-007	4.81e-006	0.5119	0.31
4100	4100	1.09e+001	0.00e+000	1.09e+001	0.00	4.81e-007	4.81e-006	0.512	0.31
4200	4200	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.512	0.31
4300	4300	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.5121	0.31
4400	4400	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.5121	0.31
4500	4500	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.5122	0.31
4600	4600	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.5122	0.31
4700	4700	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.5123	0.31
4800	4800	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.5123	0.31
4900	4900	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.5123	0.31

5000	5000	1.09e+001	0.00e+000	1.09e+001	0.00	4.82e-007	4.82e-006	0.5124	0.31
5100	5100	1.09e+001	0.00e+000	1.09e+001	0.00	4.83e-007	4.83e-006	0.5124	0.31
5200	5200	1.09e+001	0.00e+000	1.09e+001	0.00	4.83e-007	4.83e-006	0.5125	0.31
5300	5300	1.09e+001	0.00e+000	1.09e+001	0.00	4.83e-007	4.83e-006	0.5125	0.31
5400	5400	1.09e+001	0.00e+000	1.09e+001	0.00	4.83e-007	4.83e-006	0.5126	0.31
5500	5500	1.09e+001	0.00e+000	1.09e+001	0.00	4.83e-007	4.83e-006	0.5126	0.31
5600	5600	1.09e+001	0.00e+000	1.09e+001	0.00	4.83e-007	4.83e-006	0.5127	0.31
5700	5700	1.09e+001	0.00e+000	1.09e+001	0.00	4.83e-007	4.83e-006	0.5127	0.31
5800	5800	1.09e+001	0.00e+000	1.09e+001	0.00	4.83e-007	4.83e-006	0.5128	0.31
5900	5900	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.5128	0.31
6000	6000	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.5129	0.31
6100	6100	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.5129	0.31
6200	6200	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.513	0.31
6300	6300	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.513	0.31
6400	6400	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.5131	0.32
6500	6500	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.5131	0.32
6600	6600	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.5132	0.32
6700	6700	1.09e+001	0.00e+000	1.09e+001	0.00	4.84e-007	4.84e-006	0.5132	0.32
6800	6800	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5133	0.32
6900	6900	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5133	0.32
7000	7000	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5134	0.32
7100	7100	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5134	0.32
7200	7200	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5135	0.32
7300	7300	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5135	0.32
7400	7400	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5136	0.32
7500	7500	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5136	0.32
7600	7600	1.09e+001	0.00e+000	1.09e+001	0.00	4.85e-007	4.85e-006	0.5137	0.32
7700	7700	1.09e+001	0.00e+000	1.09e+001	0.00	4.86e-007	4.86e-006	0.5137	0.32
7800	7800	1.09e+001	0.00e+000	1.09e+001	0.00	4.86e-007	4.86e-006	0.5137	0.32
7900	7900	1.09e+001	0.00e+000	1.09e+001	0.00	4.86e-007	4.86e-006	0.5138	0.32
8000	8000	1.09e+001	0.00e+000	1.09e+001	0.00	4.86e-007	4.86e-006	0.5138	0.32
8100	8100	1.09e+001	0.00e+000	1.09e+001	0.00	4.86e-007	4.86e-006	0.5139	0.32
8200	8200	1.09e+001	0.00e+000	1.09e+001	0.00	4.86e-007	4.86e-006	0.5139	0.32
8300	8300	1.09e+001	0.00e+000	1.09e+001	0.00	4.86e-007	4.86e-006	0.514	0.32
8400	8400	1.09e+001	0.00e+000	1.09e+001	0.00	4.86e-007	4.86e-006	0.514	0.32
8500	8500	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5141	0.32
8600	8600	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5141	0.32
8700	8700	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5142	0.32
8800	8800	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5142	0.32
8900	8900	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5143	0.32
9000	9000	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5143	0.32
9100	9100	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5144	0.32
9200	9200	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5144	0.32
9300	9300	1.09e+001	0.00e+000	1.09e+001	0.00	4.87e-007	4.87e-006	0.5145	0.32
9400	9400	1.09e+001	0.00e+000	1.09e+001	0.00	4.88e-007	4.88e-006	0.5145	0.32

9500	9500	1.09e+001	0.00e+000	1.09e+001	0.00	4.88e-007	4.88e-006	0.5146	0.32
9600	9600	1.09e+001	0.00e+000	1.09e+001	0.00	4.88e-007	4.88e-006	0.5146	0.32
9700	9700	1.09e+001	0.00e+000	1.09e+001	0.00	4.88e-007	4.88e-006	0.5147	0.32
9800	9800	1.09e+001	0.00e+000	1.09e+001	0.00	4.88e-007	4.88e-006	0.5147	0.32
9900	9900	1.09e+001	0.00e+000	1.09e+001	0.00	4.88e-007	4.88e-006	0.5148	0.32
10000	10000	1.09e+001	0.00e+000	1.09e+001	0.00	4.88e-007	4.88e-006	0.5148	0.32

End of pc-CRACK Output

Output for IGSCC case with WOL residual stresses:

tm
pc-CRACK for Windows
Version 3.1-98348
(C) Copyright '84 - '98
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: Mon Dec 01 14:53:25 2008
Input Data and Results File: N2.LFM

Title: JAF N2 Crack Growth with WOL

Load Cases:

Case ID: P1_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-39.7170
0.0793	-40.3490
0.1587	-40.7120
0.2380	-40.9920
0.3173	-40.0580
0.3967	-36.4000
0.4760	-30.3220
0.5553	-22.7690
0.6347	-12.5050
0.7140	-1.5176
0.7933	3.8362
0.8727	6.5966
0.9520	8.8339
1.0313	10.6030
1.1107	11.4380
1.1900	11.8810
1.2693	13.8740

1.3487	17.0970
1.4280	18.6230
1.5073	18.0990
1.5867	15.5500

Case ID: P2_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-40.6750
0.0792	-38.7950
0.1584	-36.3090
0.2376	-35.6780
0.3168	-38.8330
0.3960	-33.5040
0.4752	-39.3260
0.5544	-36.5530
0.6336	-21.1880
0.7128	-4.6270
0.7920	9.1298
0.8712	15.3010
0.9503	16.8200
1.0295	16.7900
1.1087	15.8530
1.1879	14.3480
1.2671	15.4520
1.3463	20.0010
1.4255	24.3720
1.5047	27.8520
1.5839	29.3440

Case ID: P3_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-38.4610
0.0853	-39.5790
0.1707	-49.1040
0.2560	-51.6050
0.3413	-51.2820
0.4266	-47.4160
0.5120	-41.6810
0.5973	-32.7260
0.6826	-20.8590
0.7679	-9.6705

0.8533	-0.2673
0.9386	7.0081
1.0239	8.3770
1.1093	9.4758
1.1946	9.1873
1.2799	9.0162
1.3652	11.2680
1.4506	15.8210
1.5359	18.7370
1.6212	21.4980
1.7065	23.6410

Case ID: P1_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-26.5210
0.0793	-26.9270
0.1587	-26.9240
0.2380	-26.3780
0.3173	-24.6910
0.3967	-20.6710
0.4760	-14.6190
0.5553	-7.2662
0.6347	2.3816
0.7140	12.6720
0.7933	17.6200
0.8727	20.1090
0.9520	22.0400
1.0313	23.5030
1.1107	22.1790
1.1900	20.0260
1.2693	17.4550
1.3487	20.1960
1.4280	21.3010
1.5073	20.4310
1.5867	17.8390

Case ID: P2_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-32.6410
0.0792	-30.4050
0.1584	-26.2400

0.2376	-23.6480
0.3168	-25.6030
0.3960	-20.0130
0.4752	-25.0810
0.5544	-22.2480
0.6336	-7.8169
0.7128	7.6241
0.7920	20.3840
0.8712	26.0170
0.9503	27.2700
1.0295	27.0450
1.1087	24.8660
1.1879	20.2130
1.2671	16.8180
1.3463	20.8460
1.4255	24.6800
1.5047	27.6550
1.5839	28.8950

Case ID: P3_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-29.0710
0.0853	-31.1390
0.1707	-37.1380
0.2560	-38.5510
0.3413	-37.6290
0.4266	-34.0970
0.5120	-29.0900
0.5973	-20.9770
0.6826	-10.0800
0.7679	0.1012
0.8533	8.4945
0.9386	14.8890
1.0239	15.7350
1.1093	16.1220
1.1946	13.6400
1.2799	11.2460
1.3652	8.7844
1.4506	12.6900
1.5359	15.0840
1.6212	17.3120
1.7065	19.0350

Case ID	Stress Coefficients C0	C1	C2	C3	Type
P1_rsdl_70F_hoo	-42.6891	-7.07378	115.185	-56.0956	StressDist
P2_rsdl_70F_hoo	-39.4702	-30.1753	145.503	-64.3057	StressDist
P3_rsdl_70F_hoo	-42.8367	-48.9998	154.565	-62.0792	StressDist
P1_rsdl_551F_ho	-30.5175	11.0008	90.953	-50.9343	StressDist
P2_rsdl_551F_ho	-32.6415	1.43969	105.477	-53.8	StressDist
P3_rsdl_551F_ho	-34.3878	-24.6287	118.724	-52.269	StressDist
primary hoop st	7.371	0	0	0	Coeff

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

Wall Depth	Case primary ho
0.0000	7.371
0.1220	7.371
0.2440	7.371
0.3660	7.371
0.4880	7.371
0.6100	7.371
0.7320	7.371
0.8540	7.371
0.9760	7.371
1.0980	7.371
1.2200	7.371

Crack Model: Elliptical Longitudinal Crack in Cylinder (t/R=0.1,a/l=0.1)

WARNING: The stress intensity factor (K) is the maximum of
K at the surface and K at the deepest point at each crack depth.

Crack Parameters:
Wall thickness: 1.6288
Max. crack size: 1.2200

Crack Size	Case P1_rsdl_70	Case P2_rsdl_70	Case P3_rsdl_70	Case P1_rsdl_55	Case P2_rsdl_55
	----------Stress Intensity Factor----------				
0.0244	-6.71806	-6.22218	-6.76032	-4.79525	-5.13368
0.0488	-9.48828	-8.80282	-9.57471	-6.76207	-7.24594
0.0732	-11.6043	-10.784	-11.7426	-8.25709	-8.85602
0.0976	-13.3793	-12.4539	-13.5761	-9.50485	-10.2036
0.1220	-14.9344	-13.9239	-15.1956	-10.5924	-11.3814
0.1464	-16.3317	-15.2508	-16.6625	-11.5643	-12.4371
0.1708	-17.6407	-16.4992	-18.0472	-12.4699	-13.4234
0.1952	-18.9295	-17.7332	-19.4205	-13.3569	-14.392
0.2196	-20.1503	-18.907	-20.7315	-14.1919	-15.3066
0.2440	-21.3137	-20.0303	-21.9907	-14.9827	-16.1754
0.2684	-22.4279	-21.1103	-23.2059	-15.735	-17.0044
0.2928	-23.4987	-22.1523	-24.3829	-16.4531	-17.7981
0.3172	-24.5309	-23.1605	-25.5263	-17.1404	-18.5602
0.3416	-25.6197	-24.2264	-26.7386	-17.8612	-19.3613
0.3660	-26.7332	-25.3196	-27.9863	-18.5937	-20.1775
0.3904	-27.8254	-26.3954	-29.2194	-19.3064	-20.9742
0.4148	-28.8976	-27.455	-30.439	-20.0001	-21.7524
0.4392	-29.9508	-28.4989	-31.6459	-20.6755	-22.5126
0.4636	-30.9857	-29.5277	-32.8407	-21.333	-23.2553
0.4880	-32.0029	-30.5417	-34.0238	-21.973	-23.9809
0.5124	-33.1651	-31.7001	-35.3773	-22.7021	-24.808
0.5368	-34.3204	-32.8544	-36.7324	-23.4195	-25.6248
0.5612	-35.4642	-34.0000	-38.0839	-24.1222	-26.4279
0.5856	-36.5961	-35.1362	-39.4311	-24.8097	-27.2167
0.6100	-37.7156	-36.2624	-40.7733	-25.4817	-27.9908
0.6344	-38.8222	-37.3778	-42.1099	-26.1377	-28.7496
0.6588	-39.9702	-38.536	-43.5031	-26.812	-29.5319
0.6832	-41.236	-39.813	-45.0418	-26.6359	-30.3916
0.7076	-42.4914	-41.0815	-46.579	-26.054	-31.2364
0.7320	-43.7352	-42.3404	-48.1134	-25.3891	-31.7379
0.7564	-44.9667	-43.5886	-49.6438	-24.6421	-31.0844
0.7808	-46.1849	-44.8248	-51.1689	-23.8134	-30.3369
0.8052	-47.3889	-46.048	-52.6876	-22.9039	-29.4957
0.8296	-48.6983	-47.3774	-54.3414	-21.974	-28.6297
0.8540	-50.0665	-48.7665	-56.0763	-21.0074	-27.719
0.8784	-51.4199	-50.1416	-57.8054	-19.9712	-26.7251
0.9028	-52.7572	-51.5014	-59.527	-18.8676	-25.6496
0.9272	-53.1925	-52.8443	-61.2397	-17.6986	-24.4942
0.9516	-52.6735	-53.0186	-62.942	-16.4669	-23.261
0.9760	-52.0769	-52.2251	-64.6325	-15.1748	-21.952

1.0004	-51.6976	-51.6365	-66.5355	-14.0253	-20.7907
1.0248	-51.2794	-50.9895	-68.4384	-12.847	-19.5863
1.0492	-50.8105	-50.2715	-70.3271	-11.6338	-18.331
1.0736	-50.295	-49.4867	-72.1998	-10.3904	-17.0293
1.0980	-49.7375	-48.6393	-74.0551	-9.12204	-15.6858
1.1224	-49.1428	-47.7339	-75.8777	-7.83391	-14.3055
1.1468	-48.5185	-46.7905	-75.5827	-6.53329	-12.8971
1.1712	-47.8864	-45.8538	-75.2889	-5.23966	-11.4835
1.1956	-47.2532	-44.8991	-74.9613	-3.96252	-10.0689
1.2200	-46.6274	-43.935	-74.6071	-2.71053	-8.66168

----------Stress Intensity Factor----------

Crack Size	Case P3_rsdl_55	Case primary ho
0.0244	-5.42025	1.92366
0.0488	-7.6673	2.74502
0.0732	-9.39176	3.39203
0.0976	-10.8449	3.9515
0.1220	-12.1237	4.45674
0.1464	-13.2777	4.92465
0.1708	-14.3633	5.36888
0.1952	-15.4364	5.80088
0.2196	-16.4569	6.21779
0.2440	-17.4335	6.62266
0.2684	-18.3725	7.0178
0.2928	-19.2785	7.40494
0.3172	-20.1552	7.78545
0.3416	-21.0823	8.17085
0.3660	-22.0333	8.55815
0.3904	-22.9696	8.94264
0.4148	-23.8919	9.32488
0.4392	-24.8009	9.70534
0.4636	-25.6973	10.0844
0.4880	-26.5812	10.4625
0.5124	-27.5913	10.859
0.5368	-28.5985	11.2565
0.5612	-29.5988	11.6547
0.5856	-30.5916	12.0536
0.6100	-31.5764	12.4535
0.6344	-32.5526	12.8544
0.6588	-33.5671	13.2633
0.6832	-34.6861	13.6898
0.7076	-35.7989	14.1185

0.7320	-36.9044	14.5494
0.7564	-38.0017	14.9826
0.7808	-39.0899	15.4181
0.8052	-40.1681	15.856
0.8296	-41.3407	16.3116
0.8540	-42.5671	16.7796
0.8784	-43.7829	17.2508
0.9028	-44.9871	17.7251
0.9272	-46.1785	18.2026
0.9516	-47.3561	18.6832
0.9760	-48.1482	19.167
1.0004	-47.8113	19.6987
1.0248	-47.4277	20.2373
1.0492	-46.9864	20.7801
1.0736	-46.4907	21.3272
1.0980	-45.944	21.8785
1.1224	-45.3499	22.4339
1.1468	-44.7235	22.9901
1.1712	-44.099	23.5412
1.1956	-43.4594	24.0961
1.2200	-42.8116	24.6548

Crack Growth Laws:

Law ID: IGSCC_HWC
Type: Corrosion
Model: Paris

da/dN = c * (dK)^n
where
dK = Kmax - Kmin
dK > Kthres
Kmax < K1c

Material parameters:
c = 3.2000e-010
n = 3.0000
Kthres = 0.0000

Material Fracture Toughness KIc:

Material ID: Alloy 82/182

Depth	KIc
0.0000	63.2500
0.7500	63.2500
1.5000	63.2500

Material ID: high toughness

Depth	KIc
0.0000	200.0000
0.7500	200.0000
1.5000	200.0000

Initial crack size= 0.5100
Max. crack size= 1.2200

Number of blocks= 1
Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
growth	175200	100	1000	IGSCC_HWC	Alloy 82/182

Subblock	Kmax Case ID	Scale	Factor	Kmin Case ID	Scale	Factor
growth	primary hoop stress		1.0000			
	P1_rsdl_551F_hoop		1.0000			

Crack growth results:

Total Cycles /Time	Subblock Cycles /Time	Kmax	Kmin	DeltaK	R	DaDn /DaDt	Da	a	a/thk
Block: 1									
1000	1000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
2000	2000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
3000	3000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31

4000	4000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
5000	5000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
6000	6000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
7000	7000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
8000	8000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
9000	9000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
10000	10000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
11000	11000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
12000	12000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
13000	13000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
14000	14000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
15000	15000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
16000	16000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
17000	17000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
18000	18000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
19000	19000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
20000	20000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
21000	21000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
22000	22000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
23000	23000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
24000	24000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
25000	25000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
26000	26000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
27000	27000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
28000	28000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
29000	29000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
30000	30000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
31000	31000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
32000	32000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
33000	33000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
34000	34000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
35000	35000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
36000	36000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
37000	37000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
38000	38000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
39000	39000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
40000	40000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
41000	41000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
42000	42000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
43000	43000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
44000	44000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
45000	45000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
46000	46000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
47000	47000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
48000	48000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31

49000	49000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
50000	50000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
51000	51000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
52000	52000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
53000	53000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
54000	54000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
55000	55000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
56000	56000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
57000	57000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
58000	58000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
59000	59000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
60000	60000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
61000	61000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
62000	62000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
63000	63000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
64000	64000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
65000	65000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
66000	66000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
67000	67000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
68000	68000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
69000	69000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
70000	70000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
71000	71000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
72000	72000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
73000	73000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
74000	74000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
75000	75000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
76000	76000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
77000	77000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
78000	78000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
79000	79000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
80000	80000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
81000	81000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
82000	82000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
83000	83000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
84000	84000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
85000	85000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
86000	86000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
87000	87000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
88000	88000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
89000	89000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
90000	90000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
91000	91000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
92000	92000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
93000	93000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31

94000	94000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
95000	95000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
96000	96000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
97000	97000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
98000	98000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
99000	99000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
100000	100000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
101000	101000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
102000	102000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
103000	103000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
104000	104000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
105000	105000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
106000	106000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
107000	107000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
108000	108000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
109000	109000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
110000	110000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
111000	111000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
112000	112000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
113000	113000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
114000	114000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
115000	115000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
116000	116000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
117000	117000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
118000	118000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
119000	119000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
120000	120000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
121000	121000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
122000	122000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
123000	123000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
124000	124000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
125000	125000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
126000	126000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
127000	127000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
128000	128000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
129000	129000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
130000	130000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
131000	131000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
132000	132000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
133000	133000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
134000	134000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
135000	135000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
136000	136000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
137000	137000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
138000	138000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31

139000	139000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
140000	140000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
141000	141000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
142000	142000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
143000	143000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
144000	144000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
145000	145000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
146000	146000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
147000	147000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
148000	148000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
149000	149000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
150000	150000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
151000	151000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
152000	152000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
153000	153000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
154000	154000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
155000	155000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
156000	156000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
157000	157000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
158000	158000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
159000	159000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
160000	160000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
161000	161000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
162000	162000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
163000	163000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
164000	164000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
165000	165000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
166000	166000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
167000	167000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
168000	168000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
169000	169000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
170000	170000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
171000	171000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
172000	172000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
173000	173000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
174000	174000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
175000	175000	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31
175200	175200	-1.18e+001	0.00e+000	-1.18e+001	0.00	0.00e+000	0.00e+000	0.51	0.31

End of pc-CRACK Output

Output for FCG case with WOL residual stresses:

tm
pc-CRACK for Windows
Version 3.1-98348
(C) Copyright '84 - '98
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: Mon Dec 01 15:01:52 2008
Input Data and Results File: N2.LFM

Title: JAF N2 Crack Growth with WOL

Load Cases:

Case ID: P1_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-39.7170
0.0793	-40.3490
0.1587	-40.7120
0.2380	-40.9920
0.3173	-40.0580
0.3967	-36.4000
0.4760	-30.3220
0.5553	-22.7690
0.6347	-12.5050
0.7140	-1.5176
0.7933	3.8362
0.8727	6.5966
0.9520	8.8339
1.0313	10.6030
1.1107	11.4380
1.1900	11.8810
1.2693	13.8740

1.3487	17.0970
1.4280	18.6230
1.5073	18.0990
1.5867	15.5500

Case ID: P2_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-40.6750
0.0792	-38.7950
0.1584	-36.3090
0.2376	-35.6780
0.3168	-38.8330
0.3960	-33.5040
0.4752	-39.3260
0.5544	-36.5530
0.6336	-21.1880
0.7128	-4.6270
0.7920	9.1298
0.8712	15.3010
0.9503	16.8200
1.0295	16.7900
1.1087	15.8530
1.1879	14.3480
1.2671	15.4520
1.3463	20.0010
1.4255	24.3720
1.5047	27.8520
1.5839	29.3440

Case ID: P3_rsdl_70F_hoop --- Stress Distribution

Depth	Stress
0.0000	-38.4610
0.0853	-39.5790
0.1707	-49.1040
0.2560	-51.6050
0.3413	-51.2820
0.4266	-47.4160
0.5120	-41.6810
0.5973	-32.7260
0.6826	-20.8590
0.7679	-9.6705

0.8533	-0.2673
0.9386	7.0081
1.0239	8.3770
1.1093	9.4758
1.1946	9.1873
1.2799	9.0162
1.3652	11.2680
1.4506	15.8210
1.5359	18.7370
1.6212	21.4980
1.7065	23.6410

Case ID: P1_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-26.5210
0.0793	-26.9270
0.1587	-26.9240
0.2380	-26.3780
0.3173	-24.6910
0.3967	-20.6710
0.4760	-14.6190
0.5553	-7.2662
0.6347	2.3816
0.7140	12.6720
0.7933	17.6200
0.8727	20.1090
0.9520	22.0400
1.0313	23.5030
1.1107	22.1790
1.1900	20.0260
1.2693	17.4550
1.3487	20.1960
1.4280	21.3010
1.5073	20.4310
1.5867	17.8390

Case ID: P2_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-32.6410
0.0792	-30.4050
0.1584	-26.2400

0.2376	-23.6480
0.3168	-25.6030
0.3960	-20.0130
0.4752	-25.0810
0.5544	-22.2480
0.6336	-7.8169
0.7128	7.6241
0.7920	20.3840
0.8712	26.0170
0.9503	27.2700
1.0295	27.0450
1.1087	24.8660
1.1879	20.2130
1.2671	16.8180
1.3463	20.8460
1.4255	24.6800
1.5047	27.6550
1.5839	28.8950

Case ID: P3_rsdl_551F_hoop --- Stress Distribution

Depth	Stress
0.0000	-29.0710
0.0853	-31.1390
0.1707	-37.1380
0.2560	-38.5510
0.3413	-37.6290
0.4266	-34.0970
0.5120	-29.0900
0.5973	-20.9770
0.6826	-10.0800
0.7679	0.1012
0.8533	8.4945
0.9386	14.8890
1.0239	15.7350
1.1093	16.1220
1.1946	13.6400
1.2799	11.2460
1.3652	8.7844
1.4506	12.6900
1.5359	15.0840
1.6212	17.3120
1.7065	19.0350

Case ID	Stress Coefficients C0	C1	C2	C3	Type
P1_rsdl_70F_hoo	-42.6891	-7.07378	115.185	-56.0956	StressDist
P2_rsdl_70F_hoo	-39.4702	-30.1753	145.503	-64.3057	StressDist
P3_rsdl_70F_hoo	-42.8367	-48.9998	154.565	-62.0792	StressDist
P1_rsdl_551F_ho	-30.5175	11.0008	90.953	-50.9343	StressDist
P2_rsdl_551F_ho	-32.6415	1.43969	105.477	-53.8	StressDist
P3_rsdl_551F_ho	-34.3878	-24.6287	118.724	-52.269	StressDist
primary hoop st	7.371	0	0	0	Coeff

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

Wall Depth	Case primary ho
0.0000	7.371
0.1220	7.371
0.2440	7.371
0.3660	7.371
0.4880	7.371
0.6100	7.371
0.7320	7.371
0.8540	7.371
0.9760	7.371
1.0980	7.371
1.2200	7.371

Crack Model: Elliptical Longitudinal Crack in Cylinder (t/R=0.1,a/l=0.1)

WARNING: The stress intensity factor (K) is the maximum of
K at the surface and K at the deepest point at each crack depth.

Crack Parameters:
Wall thickness: 1.6288
Max. crack size: 1.2200

----------Stress Intensity Factor----------

Crack Size	Case P1_rsdl_70	Case P2_rsdl_70	Case P3_rsdl_70	Case P1_rsdl_55	Case P2_rsdl_55

0.0244	-6.71806	-6.22218	-6.76032	-4.79525	-5.13368
0.0488	-9.48828	-8.80282	-9.57471	-6.76207	-7.24594
0.0732	-11.6043	-10.784	-11.7426	-8.25709	-8.85602
0.0976	-13.3793	-12.4539	-13.5761	-9.50485	-10.2036
0.1220	-14.9344	-13.9239	-15.1956	-10.5924	-11.3814
0.1464	-16.3317	-15.2508	-16.6625	-11.5643	-12.4371
0.1708	-17.6407	-16.4992	-18.0472	-12.4699	-13.4234
0.1952	-18.9295	-17.7332	-19.4205	-13.3569	-14.392
0.2196	-20.1503	-18.907	-20.7315	-14.1919	-15.3066
0.2440	-21.3137	-20.0303	-21.9907	-14.9827	-16.1754
0.2684	-22.4279	-21.1103	-23.2059	-15.735	-17.0044
0.2928	-23.4987	-22.1523	-24.3829	-16.4531	-17.7981
0.3172	-24.5309	-23.1605	-25.5263	-17.1404	-18.5602
0.3416	-25.6197	-24.2264	-26.7386	-17.8612	-19.3613
0.3660	-26.7332	-25.3196	-27.9863	-18.5937	-20.1775
0.3904	-27.8254	-26.3954	-29.2194	-19.3064	-20.9742
0.4148	-28.8976	-27.455	-30.439	-20.0001	-21.7524
0.4392	-29.9508	-28.4989	-31.6459	-20.6755	-22.5126
0.4636	-30.9857	-29.5277	-32.8407	-21.333	-23.2553
0.4880	-32.0029	-30.5417	-34.0238	-21.973	-23.9809
0.5124	-33.1651	-31.7001	-35.3773	-22.7021	-24.808
0.5368	-34.3204	-32.8544	-36.7324	-23.4195	-25.6248
0.5612	-35.4642	-34	-38.0839	-24.1222	-26.4279
0.5856	-36.5961	-35.1362	-39.4311	-24.8097	-27.2167
0.6100	-37.7156	-36.2624	-40.7733	-25.4817	-27.9908
0.6344	-38.8222	-37.3778	-42.1099	-26.1377	-28.7496
0.6588	-39.9702	-38.536	-43.5031	-26.812	-29.5319
0.6832	-41.236	-39.813	-45.0418	-26.6359	-30.3916
0.7076	-42.4914	-41.0815	-46.579	-26.054	-31.2364
0.7320	-43.7352	-42.3404	-48.1134	-25.3891	-31.7379
0.7564	-44.9667	-43.5886	-49.6438	-24.6421	-31.0844
0.7808	-46.1849	-44.8248	-51.1689	-23.8134	-30.3369
0.8052	-47.3889	-46.048	-52.6876	-22.9039	-29.4957
0.8296	-48.6983	-47.3774	-54.3414	-21.974	-28.6297
0.8540	-50.0665	-48.7665	-56.0763	-21.0074	-27.719
0.8784	-51.4199	-50.1416	-57.8054	-19.9712	-26.7251
0.9028	-52.7572	-51.5014	-59.527	-18.8676	-25.6496
0.9272	-53.1925	-52.8443	-61.2397	-17.6986	-24.4942
0.9516	-52.6735	-53.0186	-62.942	-16.4669	-23.261
0.9760	-52.0769	-52.2251	-64.6325	-15.1748	-21.952
1.0004	-51.6976	-51.6365	-66.5355	-14.0253	-20.7907
1.0248	-51.2794	-50.9895	-68.4384	-12.847	-19.5863
1.0492	-50.8105	-50.2715	-70.3271	-11.6338	-18.331
1.0736	-50.295	-49.4867	-72.1998	-10.3904	-17.0293
1.0980	-49.7375	-48.6393	-74.0551	-9.12204	-15.6858

1.1224	-49.1428	-47.7339	-75.8777	-7.83391	-14.3055
1.1468	-48.5185	-46.7905	-75.5827	-6.53329	-12.8971
1.1712	-47.8864	-45.8538	-75.2889	-5.23966	-11.4835
1.1956	-47.2532	-44.8991	-74.9613	-3.96252	-10.0689
1.2200	-46.6274	-43.935	-74.6071	-2.71053	-8.66168

----------Stress Intensity Factor----------

Crack Size	Case P3_rsdl_55	Case primary ho
0.0244	-5.42025	1.92366
0.0488	-7.6673	2.74502
0.0732	-9.39176	3.39203
0.0976	-10.8449	3.9515
0.1220	-12.1237	4.45674
0.1464	-13.2777	4.92465
0.1708	-14.3633	5.36888
0.1952	-15.4364	5.80088
0.2196	-16.4569	6.21779
0.2440	-17.4335	6.62266
0.2684	-18.3725	7.0178
0.2928	-19.2785	7.40494
0.3172	-20.1552	7.78545
0.3416	-21.0823	8.17085
0.3660	-22.0333	8.55815
0.3904	-22.9696	8.94264
0.4148	-23.8919	9.32488
0.4392	-24.8009	9.70534
0.4636	-25.6973	10.0844
0.4880	-26.5812	10.4625
0.5124	-27.5913	10.859
0.5368	-28.5985	11.2565
0.5612	-29.5988	11.6547
0.5856	-30.5916	12.0536
0.6100	-31.5764	12.4535
0.6344	-32.5526	12.8544
0.6588	-33.5671	13.2633
0.6832	-34.6861	13.6898
0.7076	-35.7989	14.1185
0.7320	-36.9044	14.5494
0.7564	-38.0017	14.9826
0.7808	-39.0899	15.4181
0.8052	-40.1681	15.856
0.8296	-41.3407	16.3116

0.8540	-42.5671	16.7796
0.8784	-43.7829	17.2508
0.9028	-44.9871	17.7251
0.9272	-46.1785	18.2026
0.9516	-47.3561	18.6832
0.9760	-48.1482	19.167
1.0004	-47.8113	19.6987
1.0248	-47.4277	20.2373
1.0492	-46.9864	20.7801
1.0736	-46.4907	21.3272
1.0980	-45.944	21.8785
1.1224	-45.3499	22.4339
1.1468	-44.7235	22.9901
1.1712	-44.099	23.5412
1.1956	-43.4594	24.0961
1.2200	-42.8116	24.6548

Crack Growth Laws:

Law ID: Fatigue_551
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 = 1.8424e-010
is for the currently selected units of:
force: kip
length: inch
temperature: 551.0000 Fahrenheit

Material Fracture Toughness KIc:

Material ID: Alloy 82/182

Depth	KIc
0.0000	63.2500
0.7500	63.2500
1.5000	63.2500

Material ID: high toughness

Depth	KIc
0.0000	200.0000
0.7500	200.0000
1.5000	200.0000

Initial crack size= 0.5100
Max. crack size= 1.2200

Number of blocks= 1
Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
growth	10000	10	100	Fatigue_551	Alloy 82/182

Subblock	Kmax Case ID	Kmax Scale Factor	Kmin Case ID	Kmin Scale Factor
growth	primary hoop stress	1.0000	P2_rsdl_70F_hoop	1.0000
	P1_rsdl_551F_hoop	1.0000		

Crack growth results:

Total Cycles /Time	Subblock Cycles /Time	Kmax	Kmin	DeltaK	R	DaDn /DaDt	Da	a	a/thk
Block: 1									
100	100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
200	200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
300	300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31

400	400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
500	500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
600	600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
700	700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
800	800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
900	900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1000	1000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1100	1100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1200	1200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1300	1300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1400	1400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1500	1500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1600	1600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1700	1700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1800	1800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
1900	1900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2000	2000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2100	2100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2200	2200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2300	2300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2400	2400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2500	2500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2600	2600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2700	2700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2800	2800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
2900	2900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3000	3000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3100	3100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3200	3200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3300	3300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3400	3400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3500	3500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3600	3600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3700	3700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3800	3800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
3900	3900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4000	4000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4100	4100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4200	4200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4300	4300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4400	4400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4500	4500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4600	4600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4700	4700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
4800	4800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31

4900	4900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5000	5000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5100	5100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5200	5200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5300	5300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5400	5400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5500	5500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5600	5600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5700	5700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5800	5800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
5900	5900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6000	6000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6100	6100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6200	6200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6300	6300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6400	6400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6500	6500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6600	6600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6700	6700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6800	6800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
6900	6900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7000	7000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7100	7100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7200	7200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7300	7300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7400	7400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7500	7500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7600	7600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7700	7700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7800	7800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
7900	7900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8000	8000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8100	8100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8200	8200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8300	8300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8400	8400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8500	8500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8600	8600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8700	8700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8800	8800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
8900	8900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9000	9000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9100	9100	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9200	9200	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9300	9300	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31

9400	9400	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9500	9500	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9600	9600	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9700	9700	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9800	9800	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
9900	9900	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31
10000	10000	-1.18e+001	-3.16e+001	1.98e+001	2.67	0.00e+000	0.00e+000	0.51	0.31

End of pc-CRACK Output