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Point Beach Nuclear Plant
Operated by Nuclear Management Company, LLC

May 15, 2004

NRC 2004-0053
10 CFR 50.55a(a)(3)(i)
10 CFR 50.55a(g)(5)(iii)

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

Point Beach Nuclear Plant, Units 1 and 2
Dockets 50-266
License Nos. DPR-24
Supplement 1 to Reactor Vessel Closure Head Penetration Repair and Flaw Characterization Relief Requests MR 02-018-1, Revision 1 and MR 02-018-2, Revision 1

Reference: (1) Letter from NMC to NRC dated May 13, 2004 (NRC 2004-0051)
(2) NRC Safety Evaluation dated September 10, 2003
(3) NRC Safety Evaluation dated September 24, 2003

In reference 1, Nuclear Management Company (NMC) LLC, licensee for Point Beach Nuclear Plant (PBNP), requested revision to the relief, granted in references 2 and 3, pertaining to reactor vessel closure head (RVCH) penetration repair and flaw characterization.

During a conference call between NRC staff and NMC personnel on May 15, 2004, the staff requested additional information in support of their review of Reference 1, regarding crack growth rates in addition to those documented in EPRI MRP-55, "Materials Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick-Wall Alloy 600 Material." Enclosure 1 to this letter provides the additional information requested by the staff.

This submittal provides revised primary water stress corrosion cracking (PWSCC) crack growth correlations and fatigue crack growth calculations, for the repair and flaw characterization, where portions of the new pressure boundary weld overlap onto portions of the remnant J-groove weld. These correlations and calculations address hypothetical growth in Alloy 82 material as a conservative representation for Alloy 52.

The conclusion of the revised calculation shows that, even with the very conservative assumption of using Alloy 82 crack growth rates for Alloy 52 weld material, a hypothetical remnant weld crack will not grow through the repair weld ligament for 1.4 effective full power years (EFPY) of operation. Therefore, the hypothetical flaw could not progress sufficiently to go through the pressure boundary during the next Unit 1 operating cycle.

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J-89

This submittal contains no new or revised regulatory commitments.

Gary D. Van Middlesworth
Site Vice-President, Point Beach Nuclear Plant
Nuclear Management Company, LLC

Enclosure: I - Structural Integrity Associates Calculation PBCH-09Q-302, Revision 2, Dated May 15, 2004

cc: Project Manager, Point Beach Nuclear Plant, NRR, USNRC
Regional Administrator, Region III, USNRC
NRC Resident Inspector - Point Beach Nuclear Plant
PSCW

ENCLOSURE I

STRUCTURAL INTEGRITY ASSOCIATES CALCULATION PBCH-09Q-302, REVISION 2, DATED MAY 15, 2004
PWSCC CRACK GROWTH CORRELATIONS AND FATIGUE CRACK GROWTH CALCULATIONS FOR POINT BEACH UNIT 1

POINT BEACH NUCLEAR PLANT, UNIT 1

STRUCTURAL INTEGRITY Associates, Inc.	**CALCULATION PACKAGE**	FILE No.: PBCH-09Q-302 PROJECT No.: PBCH-09Q

PROJECT NAME: Point Beach Unit 1 CRDM Top Head Analysis

CLIENT: NMC Point Beach Nuclear Plant

CALCULATION TITLE: PWSCC Crack Growth Correlations and Fatigue Crack Growth Calculations for Point Beach Unit 1

Document Revision	Affected Pages	Revision Description	Project Mgr. Approval Signature & Date	Preparer(s) & Checker(s) Signatures & Date
0	1-7 A1 – A19	Original Issue	H. L. GUSTIN 2/17/04	H. L. GUSTIN 2/17/04 G. L. STEVENS 2/17/04
1	1-7 A1-A19	Incorporates actual overlap measurements for nozzle 26. Appendix A is not affected.	H. L. GUSTIN 5/12/04	H. L. GUSTIN 5/12/04 MING QIN 5/12/04
2	1-8 A1-A19	Addresses hypothetical growth in Alloy 82 material, as a conservative representation for Alloy 52	H. L. GUSTIN 5/15/04	H. L. GUSTIN 5/15/04 P. C. RICCARDELLA 5/15/04

1.0 STATEMENT OF PROBLEM

Point Beach Unit 1 is proceeding with repair of RPV top head CRDM Nozzle 26 during the current, Spring 2004 refueling outage. Because of the steepness of this nozzle, and the relatively small head diameter and thickness, the standard Framatome repair process will result in a portion of the new attachment weld overlapping the original Alloy-82/182 weld over a portion of the circumference (see Figure 1).

In order to evaluate repair options for the Point Beach Unit 1 Top Head CRDM penetrations, this calculation evaluates the growth of hypothetical flaws in the original alloy 82/182 weld through the weld repair fusion line with the low alloy steel base material. Earlier revisions of this calculation assumed a crack growth rate applicable to Alloy-600 base metal. To respond to NRC comments received on the earlier calculation, the calculation is revised herein to incorporate crack growth rates applicable to Alloy 82 weld metal.

Note that the repair weld through which the hypothetical crack is assumed to be propagating is Alloy-52, which has generally been shown to be highly resistant to PWSCC cracking and crack growth. The only potential crack growth region is at the fusion line between the low alloy steel nozzle and the Alloy-52 weld metal, in which some dilution of the weld metal may occur. Both the Alloy-600 and Alloy-82 crack growth curves are believed to be conservative approximations of the expected crack growth rate in this dilution zone.

2.0 METHODOLOGY

Stress intensity factors at the interface of the new, Alloy-52 repair weld and the original, Alloy-82/182 J-groove weld have been computed in Ref [5] assuming the entire original J-groove weld to be cracked. These K-levels are based on operating plus residual stresses resulting from the original J-groove weld plus the new repair weld, at normal operating conditions. The result K-levels are assumed to remain constant for the small amount of crack extension through the interface region, since the cracking will be confined to a narrow region of diluted material.

The resulting K-levels are then inserted into a stress corrosion crack growth law (see section 3.0 below) to determine the rate of crack propagation versus time, and to predict the time necessary for the assumed initial crack to grow through the new repair weld diluted zone and thus cause potential leakage during the upcoming fuel cycle.

3.0 MATERIAL CRACK GROWTH RATE

The industry has established a panel of experts on stress corrosion cracking to review available data on PWSCC growth in components such as the CRDM penetration tubes and associated nickel-based weld metals. The panel is comprised of international experts, including representatives from NRC research and its contractors. This panel has established a recommended crack growth law for Alloy-600 base material [1], and more recently a recommended crack growth curves for Alloy 82 and 182 weld metals [2]. The correlation of available crack growth data from [2] is shown in Figure 2, normalized to a service temperature of 617 °F. The reported top head temperature for Point Beach Unit 1 is 592°F [7]. The crack growth rate is a strong function of temperature, and so to represent the Point Beach condition, it is necessary to adjust the Alloy-82 crack growth correlation for the lower temperature. References 1 and 2 also provide an activation energy equation for temperature adjustment of the crack growth curves.

For Alloy-82 weld material the PWSCC crack growth correlation reported in [2], adjusted to the Point Beach head temperature of 592°F is

$$da/dt = 5.12 \times 10^{-08} (K-K_{th})^{1.6}$$

where:

da/dt = crack growth rate at temperature T in in/hr
K = crack tip stress intensity factor (ksi√in)
K_{th} = crack tip stress intensity factor threshold
= 0 (ksi√in)

This correlation is applicable to evaluating the growth of ID connected flaws in Alloy 82 GTAW weld material. Since the diluted zone being evaluated in this calculation is Alloy-52, also a GTAW welding process, the Alloy-82 curve is conservatively applied.

As noted above, the repair material is Alloy 52. Since chromium content has been shown to be a key contributor to nickel-based alloy PWSCC resistance, this material (Alloy 52, with a chromium content of 28-31%) will have significantly higher PWSCC resistance than will Alloy 600 (chromium content 14-17%) or its associated weld materials Alloy 182 (chromium content 13-17%) or Alloy 82 (chromium content 18-22 %). The lower chromium content of the Alloy -82 material is deemed sufficient to account for the potential effects of dilution of the Alloy-52 material in the interface region with the low alloy steel head.

4.0 CRACK GROWTH CALCULATIONS

The objective of the calculation is to determine the time that would be required for a crack at the interface of the Alloy 52 repair material, the low alloy steel head material, and the underlying J-groove material to propagate parallel to the repair weld by a PWSCC mechanism through a distance defined by the repair weld ligament. If the time for such propagation is greater than the remaining service life of the head, no penetration of the pressure boundary due to such a crack would be predicted.

The above crack growth correlation was used with the SI program pc-CRACK [3] to perform PWSCC crack growth calculations. A hypothetical flaw was considered, which represents the bounds on geometries that may be encountered. This hypothetical flaw was a flaw in the axial-radial plane, across the entire remaining J-groove + butter. Such a flaw would be opened by hoop stresses, resulting in a tunnel crack under the repair weld.

PWSCC is driven by both applied and weld residual stresses. Based on analyses performed by Dominion Engineering [3], as summarized in another SI calculation [5], the normal operating stresses plus the weld residual stresses in the hoop direction can reasonably be represented by a constant through-wall stress intensity factor of 57 ksi$\sqrt{in}$, at the junction of the Alloy-52 repair weld and the low alloy steel head material.

The analysis assumed that the entire original J-groove weld material was degraded (cracked), so no credit was taken for any flaw initiation or growth time in the remaining J-groove material. Because a constant applied K is assumed, starting flaw size has no effect on crack growth rate.

The flaw located in the axial-radial plane (opened by hoop stresses) was determined to be the governing flaw case, since the applied plus residual stresses in the hoop direction are greater than those in the radial direction by a factor of two to four at the location of the postulated crack, based upon review of Dominion Engineering results [3] for nodes in this location. As a result, crack growth in a radial-circumferential plane would be slower by a comparable factor.

Nozzle 26 is being repaired during the Spring 2004 outage. The repair of this nozzle has a minimum remaining ligament of 0.5 inch [6]. The repair may also contain a weld root defect of 0.1 inch based on Framatome analyses. Both cases (with and without a postulated root defect) are considered here, with pc-CRACK results contained in Appendix A.

This analysis took no credit for the portion of the repair weld that overlapped the Alloy 182 material, and so as a result the repair weld ligament was considered to be reduced in length from the design value. The repair weld is Alloy 52 weld material applied by a GTAW process.

4.1 Fatigue crack growth

Fatigue crack growth is driven by cyclic stresses. For the present case, the stress state for the assumed flaws is dominated by weld residual stresses (conservatively estimated as a constant 60 ksi) which are steady state secondary stresses. These residual stresses will not vary with heat-up/cooldown and other plant cycles, and will therefore have only a limited effect on fatigue crack growth (that is, they will have some effect on R-ratio, but none on delta K values due to cyclic plant operation. For the limited period of remaining plant operation with the current vessel head (estimated at less than 100 heat-up/cooldown cycles, producing a cyclic stress of 20 ksi), propagation of the hypothetical cracks considered herein by a fatigue mechanism is estimated at approximately 0.0002 inch, and is therefore considered negligible compared to PWSCC propagation discussed above. The pc-CRACK fatigue crack growth results are also included in Appendix A.

5.0 RESULTS

The above analysis produces the following results. These results assume that an initial radial-axial flaw is present in the original J-groove weld, equal to the entire size of that weld. The growth is then calculated for the indicated remaining ligament length of potentially diluted Alloy-52 weld metal in the repair weld..

For the nozzle 26 repair (remaining ligament = 0.5 inch without an assumed root defect, or 0.4 inch with an assumed root defect), the time required for the assumed flaw to propagate through the remaining ligament is 1.73 EFPY (15200 EFPH) for the no root defect case, and 1.39 EFPY (12200 EFPH) for the root defect case. A crack would have to propagate through this remaining ligament before leakage and possible wastage of the vessel head material could occur.

The conclusion of this calculation is that, even with the very conservative assumption of using Alloy 82 crack growth rates for Alloy 52 weld material, a hypothetical remnant weld crack will not grow through the repair weld ligament for essentially all of the remaining cycle of operation before the reactor vessel head is replaced during the next scheduled refueling outage.

6.0 REFERENCES

1. Materials Reliability Program, "Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick-Wall Alloy 600 Material," MRP-55, Revision 1, November 2002. EPRI Proprietary

2. Minutes of EPRI-MRP PWSCC Crack Growth Expert Panel Meeting, October 3, 2003 – Gaithersburg, Maryland, EPRI Letter PWR-MRP 2003-38 by John Hickling, October 20, 2003. MRP Proprietary.

3. Dominion Engineering, "Point Beach Unit 1 CRDM Nozzle Repair Weld Analysis" Calculation C-4430-00-2, Revision 1, SI File PBCH-09Q-204.

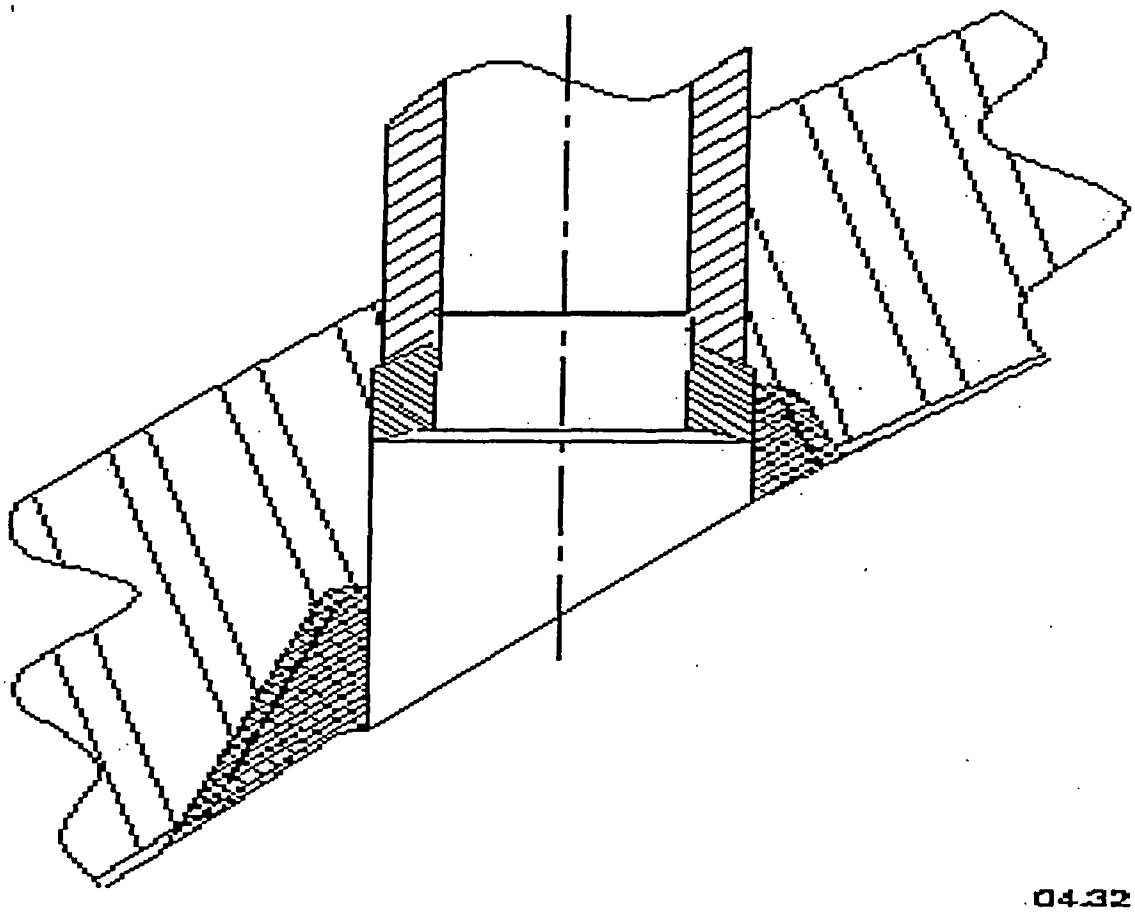
4. Structural Integrity Associates, **pc-CRACK^{tm} for Windows**, version 3.1-98348.

5. Calculation, "Fracture Mechanics Evaluation of Point Beach Unit 1 Top Head CRDM 43.5 Degree Azimuth Penetration Weld Repair," PBCH-09Q-301, Revision 0.

6. E-mail from Brian Kemp (NMC) to Hal Gustin (SI) 5/12/04

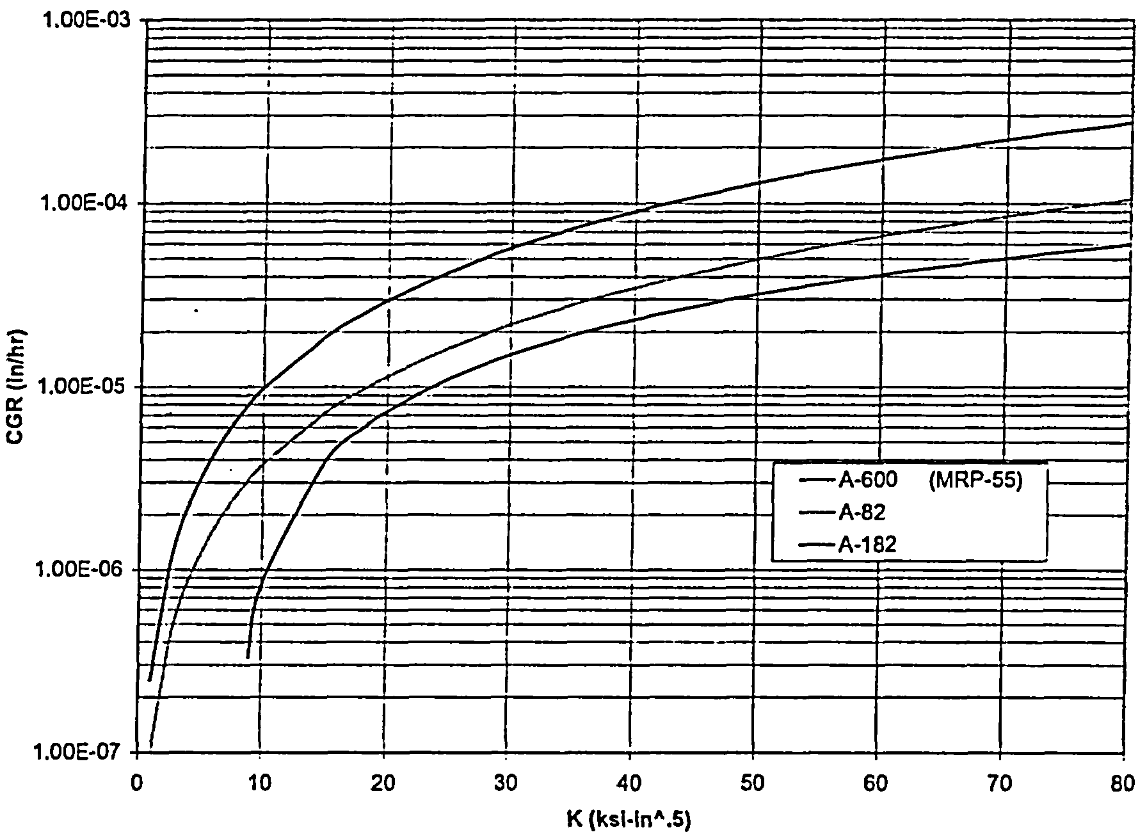
7. Materials Reliability Program, "Interim Alloy 600 Safety Assessments for US PWR Plants, Part 2: Reactor Vessel Top Head penetrations," MRP-44, EPRI Report No. TP-1001491, Part 2, May 2001

Figure 1 – Illustration of Nozzle 26 Repair and Associated Overlap Region



	Revision	0	1	2	
	Preparer/Date	HLG 2/17/04	HLG 5/12/04	HLG 5/15/04	
	Checker/Date	GLS 2/17/04	MQ 5/12/04	PCR 5/15/04	

Figure 2 – Alloy-82 and -182 Crack Growth Rate Correlations at 617 °F, from Reference [2]



APPENDIX A
FLAW GROWTH CALCULATIONS: PC-CRACK OUTPUT

tm
pc-CRACK for Windows
Version 3.1-98348

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

Linear Elastic Fracture Mechanics

Date: Thu May 13 15:05:22 2004
Input Data and Results File: ALLOY82.LFM

Title: PBCH-09Q: PWSCC Calculation using Alloy 82

Load Cases:

Case ID: PWSCC --- K vs a

Depth	K
0.0000	57.0000
0.5000	57.0000
2.0000	57.0000

	Stress Coefficients				
Case ID	C0	C1	C2	C3	Type
PWSCC	0	0	0	0	K vs a

Crack Model: User Input K Versus Crack Size

Crack Parameters:
Max. crack size: 1.0000

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

Crack Size	Case PWSCC
0.0200	57
0.0400	57
0.0600	57
0.0800	57
0.1000	57
0.1200	57
0.1400	57
0.1600	57
0.1800	57
0.2000	57
0.2200	57
0.2400	57
0.2600	57
0.2800	57
0.3000	57
0.3200	57
0.3400	57
0.3600	57
0.3800	57
0.4000	57
0.4200	57
0.4400	57
0.4600	57
0.4800	57
0.5000	57
0.5200	57
0.5400	57
0.5600	57
0.5800	57
0.6000	57
0.6200	57
0.6400	57
0.6600	57
0.6800	57

0.7000	57
0.7200	57
0.7400	57
0.7600	57
0.7800	57
0.8000	57
0.8200	57
0.8400	57
0.8600	57
0.8800	57
0.9000	57
0.9200	57
0.9400	57
0.9600	57
0.9800	57
1.0000	57

Crack Growth Laws:

Law ID: Alloy 82
Type: Corrosion
Model: Paris

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

Material parameters:
c = 5.1200e-008
n = 1.6000
Kthres = 0.0000

Material Fracture Toughness KIc:

Material ID: Alloy 52

Depth KIc

0.0000	200.0000
0.5000	200.0000
2.0000	200.0000

Initial crack size= 0.0100
Max. crack size= 1.0000

Number of blocks= 1
Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
PWSCC	40000	100	100	Alloy 82	Alloy 52

Subblock	Kmax Case ID	Kmax Scale Factor	Kmin Case ID	Kmin Scale Factor
PWSCC	PWSCC	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	4.03e+001	0.00e+000	4.03e+001	0.00	1.90e-005	1.90e-003	0.0119	0.00
200	200	4.40e+001	0.00e+000	4.40e+001	0.00	2.18e-005	2.18e-003	0.01407	-247674372620288.00
300	300	4.78e+001	0.00e+000	4.78e+001	0.00	2.49e-005	2.49e-003	0.01657	593.04
400	400	5.19e+001	0.00e+000	5.19e+001	0.00	2.84e-005	2.84e-003	0.01941	-0.00
500	500	5.61e+001	0.00e+000	5.61e+001	0.00	3.22e-005	3.22e-003	0.02263	-0.00
600	600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.02593	0.00
700	700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.02923	0.00

800	800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.03253	0.00
900	900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.03583	0.00
1000	1000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.03913	0.00
1100	1100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.04244	0.00
1200	1200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.04574	0.00
1300	1300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.04904	0.00
1400	1400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.05234	0.00
1500	1500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.05564	0.00
1600	1600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.05894	0.00
1700	1700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.06224	0.00
1800	1800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.06554	0.00
1900	1900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.06885	0.00
2000	2000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.07215	0.00
2100	2100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.07545	0.00
2200	2200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.07875	0.00
2300	2300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.08205	0.00
2400	2400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.08535	0.00
2500	2500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.08865	0.00
2600	2600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.09195	0.00
2700	2700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.09525	0.00
2800	2800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.09856	0.00
2900	2900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1019	0.00
3000	3000	5.70e+001	0.00c+000	5.70c+001	0.00	3.30e-005	3.30e-003	0.1052	0.00
3100	3100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1085	0.00
3200	3200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1118	0.00
3300	3300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1151	0.00
3400	3400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1184	0.00
3500	3500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1217	0.00
3600	3600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.125	0.00
3700	3700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1283	0.00
3800	3800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1316	0.00
3900	3900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1349	0.00
4000	4000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1382	0.00
4100	4100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1415	0.00
4200	4200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1448	0.00
4300	4300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1481	0.00
4400	4400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1514	0.00
4500	4500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1547	0.00
4600	4600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.158	0.00
4700	4700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1613	0.00
4800	4800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1646	0.00

4900	4900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1679	0.00
5000	5000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1712	0.00
5100	5100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1745	0.00
5200	5200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1778	0.00
5300	5300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1811	0.00
5400	5400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1844	0.00
5500	5500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1877	0.00
5600	5600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.191	0.00
5700	5700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1943	0.00
5800	5800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.1976	0.00
5900	5900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2009	0.00
6000	6000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2042	0.00
6100	6100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2075	0.00
6200	6200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2108	0.00
6300	6300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2141	0.00
6400	6400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2174	0.00
6500	6500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2207	0.00
6600	6600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.224	0.00
6700	6700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2273	0.00
6800	6800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2306	0.00
6900	6900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2339	0.00
7000	7000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2372	0.00
7100	7100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2405	0.00
7200	7200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2438	0.00
7300	7300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2471	0.00
7400	7400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2504	0.00
7500	7500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2537	0.00
7600	7600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.257	0.00
7700	7700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2603	0.00
7800	7800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2636	0.00
7900	7900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2669	0.00
8000	8000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2702	0.00
8100	8100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2735	0.00
8200	8200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2768	0.00
8300	8300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2801	0.00
8400	8400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2834	0.00
8500	8500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2867	0.00
8600	8600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.29	0.00
8700	8700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2933	0.00
8800	8800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2966	0.00
8900	8900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.2999	0.00

9000	9000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3032	0.00
9100	9100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3065	0.00
9200	9200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3098	0.00
9300	9300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3131	0.00
9400	9400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3164	0.00
9500	9500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3197	0.00
9600	9600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.323	0.00
9700	9700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3263	0.00
9800	9800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3296	0.00
9900	9900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3329	0.00
10000	10000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3362	0.00
10100	10100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3395	0.00
10200	10200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3428	0.00
10300	10300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3461	0.00
10400	10400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3494	0.00
10500	10500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3527	0.00
10600	10600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.356	0.00
10700	10700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3593	0.00
10800	10800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3627	0.00
10900	10900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.366	0.00
11000	11000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3693	0.00
11100	11100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3726	0.00
11200	11200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3759	0.00
11300	11300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3792	0.00
11400	11400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3825	0.00
11500	11500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3858	0.00
11600	11600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3891	0.00
11700	11700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3924	0.00
11800	11800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.3957	0.00
11900	11900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.399	0.00
12000	12000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4023	0.00
12100	12100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4056	0.00
12200	12200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4089	0.00
12300	12300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4122	0.00
12400	12400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4155	0.00
12500	12500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4188	0.00
12600	12600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4221	0.00
12700	12700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4254	0.00
12800	12800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4287	0.00
12900	12900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.432	0.00
13000	13000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4353	0.00

13100	13100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4386	0.00
13200	13200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4419	0.00
13300	13300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4452	0.00
13400	13400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4485	0.00
13500	13500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4518	0.00
13600	13600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4551	0.00
13700	13700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4584	0.00
13800	13800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4617	0.00
13900	13900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.465	0.00
14000	14000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4683	0.00
14100	14100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4716	0.00
14200	14200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4749	0.00
14300	14300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4782	0.00
14400	14400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4815	0.00
14500	14500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4848	0.00
14600	14600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4881	0.00
14700	14700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4914	0.00
14800	14800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.4947	0.00
14900	14900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.498	0.00
15000	15000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5013	0.00
15100	15100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5046	0.00
15200	15200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5079	0.00
15300	15300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5112	0.00
15400	15400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5145	0.00
15500	15500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5178	0.00
15600	15600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5211	0.00
15700	15700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5244	0.00
15800	15800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5277	0.00
15900	15900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.531	0.00
16000	16000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5343	0.00
16100	16100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5376	0.00
16200	16200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5409	0.00
16300	16300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5442	0.00
16400	16400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5475	0.00
16500	16500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5508	0.00
16600	16600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5541	0.00
16700	16700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5574	0.00
16800	16800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5607	0.00
16900	16900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.564	0.00
17000	17000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5673	0.00
17100	17100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5706	0.00

17200	17200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5739	0.00
17300	17300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5772	0.00
17400	17400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5805	0.00
17500	17500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5838	0.00
17600	17600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5871	0.00
17700	17700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5904	0.00
17800	17800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.5937	0.00
17900	17900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.597	0.00
18000	18000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6003	0.00
18100	18100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6036	0.00
18200	18200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6069	0.00
18300	18300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6102	0.00
18400	18400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6135	0.00
18500	18500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6168	0.00
18600	18600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6201	0.00
18700	18700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6234	0.00
18800	18800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6267	0.00
18900	18900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.63	0.00
19000	19000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6333	0.00
19100	19100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6366	0.00
19200	19200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.64	0.00
19300	19300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6433	0.00
19400	19400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6466	0.00
19500	19500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6499	0.00
19600	19600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6532	0.00
19700	19700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6565	0.00
19800	19800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6598	0.00
19900	19900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6631	0.00
20000	20000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6664	0.00
20100	20100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6697	0.00
20200	20200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.673	0.00
20300	20300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6763	0.00
20400	20400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6796	0.00
20500	20500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6829	0.00
20600	20600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6862	0.00
20700	20700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6895	0.00
20800	20800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6928	0.00
20900	20900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6961	0.00
21000	21000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.6994	0.00
21100	21100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7027	0.00
21200	21200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.706	0.00

21300	21300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7093	0.00
21400	21400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7126	0.00
21500	21500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7159	0.00
21600	21600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7192	0.00
21700	21700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7225	0.00
21800	21800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7258	0.00
21900	21900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7291	0.00
22000	22000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7324	0.00
22100	22100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7357	0.00
22200	22200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.739	0.00
22300	22300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7423	0.00
22400	22400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7456	0.00
22500	22500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7489	0.00
22600	22600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7522	0.00
22700	22700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7555	0.00
22800	22800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7588	0.00
22900	22900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7621	0.00
23000	23000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7654	0.00
23100	23100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7687	0.00
23200	23200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.772	0.00
23300	23300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7753	0.00
23400	23400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7786	0.00
23500	23500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7819	0.00
23600	23600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7852	0.00
23700	23700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7885	0.00
23800	23800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7918	0.00
23900	23900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7951	0.00
24000	24000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.7984	0.00
24100	24100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8017	0.00
24200	24200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.805	0.00
24300	24300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8083	0.00
24400	24400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8116	0.00
24500	24500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8149	0.00
24600	24600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8182	0.00
24700	24700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8215	0.00
24800	24800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8248	0.00
24900	24900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8281	0.00
25000	25000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8314	0.00
25100	25100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8347	0.00
25200	25200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.838	0.00
25300	25300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8413	0.00

25400	25400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8446	0.00
25500	25500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8479	0.00
25600	25600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8512	0.00
25700	25700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8545	0.00
25800	25800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8578	0.00
25900	25900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8611	0.00
26000	26000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8644	0.00
26100	26100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8677	0.00
26200	26200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.871	0.00
26300	26300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8743	0.00
26400	26400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8776	0.00
26500	26500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8809	0.00
26600	26600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8842	0.00
26700	26700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8875	0.00
26800	26800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8908	0.00
26900	26900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8941	0.00
27000	27000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.8974	0.00
27100	27100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9007	0.00
27200	27200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.904	0.00
27300	27300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9073	0.00
27400	27400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9106	0.00
27500	27500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.914	0.00
27600	27600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9173	0.00
27700	27700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9206	0.00
27800	27800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9239	0.00
27900	27900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9272	0.00
28000	28000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9305	0.00
28100	28100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9338	0.00
28200	28200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9371	0.00
28300	28300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9404	0.00
28400	28400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9437	0.00
28500	28500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.947	0.00
28600	28600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9503	0.00
28700	28700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9536	0.00
28800	28800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9569	0.00
28900	28900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9602	0.00
29000	29000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9635	0.00
29100	29100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9668	0.00
29200	29200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9701	0.00
29300	29300	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9734	0.00
29400	29400	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9767	0.00

29500	29500	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.98	0.00
29600	29600	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9833	0.00
29700	29700	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9866	0.00
29800	29800	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9899	0.00
29900	29900	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9932	0.00
30000	30000	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9965	0.00
30100	30100	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	0.9998	0.00
30200	30200	5.70e+001	0.00e+000	5.70e+001	0.00	3.30e-005	3.30e-003	1.003	0.00

Crack size exceeded 1.0000 at cycle/time 30200

End of pc-CRACK Output

tm
pc-CRACK for Windows
Version 3.1-98348

Structural Integrity Associates, Inc.
3315 Almaden Expressway, Suite 24
San Jose, CA 95118-1557

Linear Elastic Fracture Mechanics

Date: Mon Feb 09 10:59:19 2004
Input Data and Results File: PB1FCG.LFM

Title: PBCH-09Q-302: Point Beach Unit 1 Fatigue Crack Growth

Load Cases:

Case ID	Stress Coefficients C0	C1	C2	C3	Type
Residual	60	0	0	0	Coeff
Operating	20	0	0	0	Coeff

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

Wall Depth	Case Residual	Case Operating
0.0000	60	20
0.1000	60	20
0.2000	60	20
0.3000	60	20
0.4000	60	20
0.5000	60	20
0.6000	60	20
0.7000	60	20
0.8000	60	20
0.9000	60	20
1.0000	60	20

Crack Model: Single Edge Cracked Plate

Crack Parameters:

Plate width: 2.0000
Max. crack size: 1.0000

--------------------Stress Intensity Factor--------------------		
Crack Size	Case Residual	Case Operating
0.0200	16.2806	5.42685
0.0400	23.1837	7.7279
0.0600	28.5895	9.52983
0.0800	33.2379	11.0793
0.1000	37.4133	12.4711
0.1200	41.2605	13.7535
0.1400	44.8649	14.955
0.1600	48.2816	16.0939
0.1800	51.5488	17.1829
0.2000	54.6939	18.2313
0.2200	58.4858	19.4953
0.2400	62.2586	20.7529
0.2600	66.021	22.007
0.2800	69.7794	23.2598
0.3000	73.5391	24.513
0.3200	77.3044	25.7681
0.3400	81.0788	27.0263
0.3600	84.8651	28.2884
0.3800	88.6656	29.5552
0.4000	92.4824	30.8275
0.4200	97.0061	32.3354
0.4400	101.582	33.8605
0.4600	106.209	35.4029
0.4800	110.888	36.9626
0.5000	115.618	38.5394
0.5200	120.4	40.1334
0.5400	125.234	41.7446
0.5600	130.118	43.3727
0.5800	135.054	45.0179
0.6000	140.04	46.6799
0.6200	146.332	48.7773
0.6400	152.715	50.9049
0.6600	159.186	53.0621
0.6800	165.746	55.2486
0.7000	172.392	57.464
0.7200	179.124	59.7079
0.7400	185.94	61.98
0.7600	192.84	64.2799
0.7800	199.822	66.6073
0.8000	206.886	68.9619

0.8200	216.919	72.3064
0.8400	227.102	75.7008
0.8600	237.433	79.1444
0.8800	247.91	82.6366
0.9000	258.53	86.1767
0.9200	269.292	89.7641
0.9400	280.195	93.3982
0.9600	291.235	97.0783
0.9800	302.412	100.804
1.0000	313.724	104.575

Crack Growth Laws:

Law ID: Alloy 52
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 = 1.9352e-010
is for the currently selected units of:
force: kip
length: inch
temperature: 592.0000 Fahrenheit

Material Fracture Toughness KIc:

Material ID: Alloy 52

Depth	KIc
0.0000	200.0000
0.5000	200.0000
2.0000	200.0000

Initial crack size= 0.1000
Max. crack size= 1.0000

Revision	0	1	2	
Preparer/Date	HLG 2/17/04	HLG 5/12/04	HLG 5/15/04	
Checker/Date	GLS 2/17/04	MQ 5/12/04	PCR 5/15/04	

Number of blocks= 1
Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
FCG	1000	10	10	Alloy 52	Alloy 52

Subblock	Kmax Case ID	Kmax Scale Factor	Kmin Case ID	Kmin Scale Factor
FCG	Residual	1.0000	Residual	1.0000
	Operating	1.0000		

Crack growth results:

Total Cycles /Time	Subblock Cycles /Time	Kmax	Kmin	DeltaK	R	DaDn /DaDt	Da	a	a/thk
Block: 1									
10	10	4.99e+001	3.74e+001	1.25e+001	0.75	1.88e-006	1.88e-005	0.1	0.05
20	20	4.99e+001	3.74e+001	1.25e+001	0.75	1.88e-006	1.88e-005	0.1	0.05
30	30	4.99e+001	3.74e+001	1.25e+001	0.75	1.88e-006	1.88e-005	0.1001	0.05
40	40	4.99e+001	3.74e+001	1.25e+001	0.75	1.88e-006	1.88e-005	0.1001	0.05
50	50	4.99e+001	3.74e+001	1.25e+001	0.75	1.88e-006	1.88e-005	0.1001	0.05
60	60	4.99e+001	3.74e+001	1.25e+001	0.75	1.88e-006	1.88e-005	0.1001	0.05
70	70	4.99e+001	3.74e+001	1.25e+001	0.75	1.88e-006	1.88e-005	0.1001	0.05
80	80	4.99e+001	3.74e+001	1.25e+001	0.75	1.88e-006	1.88e-005	0.1002	0.05
90	90	4.99e+001	3.74e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1002	0.05
100	100	4.99e+001	3.74e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1002	0.05
110	110	4.99e+001	3.74e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1002	0.05
120	120	4.99e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1002	0.05
130	130	4.99e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1002	0.05
140	140	4.99e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1003	0.05
150	150	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1003	0.05
160	160	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1003	0.05
170	170	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1003	0.05
180	180	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1003	0.05
190	190	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1004	0.05
200	200	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1004	0.05
210	210	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1004	0.05
220	220	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1004	0.05
230	230	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1004	0.05
240	240	5.00e+001	3.75e+001	1.25e+001	0.75	1.89e-006	1.89e-005	0.1005	0.05
250	250	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1005	0.05

260	260	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1005	0.05
270	270	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1005	0.05
280	280	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1005	0.05
290	290	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1005	0.05
300	300	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1006	0.05
310	310	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1006	0.05
320	320	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1006	0.05
330	330	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1006	0.05
340	340	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1006	0.05
350	350	5.00e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1007	0.05
360	360	5.01e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1007	0.05
370	370	5.01e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1007	0.05
380	380	5.01e+001	3.75e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1007	0.05
390	390	5.01e+001	3.76e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1007	0.05
400	400	5.01e+001	3.76e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1008	0.05
410	410	5.01e+001	3.76e+001	1.25e+001	0.75	1.90e-006	1.90e-005	0.1008	0.05
420	420	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1008	0.05
430	430	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1008	0.05
440	440	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1008	0.05
450	450	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1009	0.05
460	460	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1009	0.05
470	470	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1009	0.05
480	480	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1009	0.05
490	490	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1009	0.05
500	500	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1009	0.05
510	510	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.101	0.05
520	520	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.101	0.05
530	530	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.101	0.05
540	540	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.101	0.05
550	550	5.01e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.101	0.05
560	560	5.02e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1011	0.05
570	570	5.02e+001	3.76e+001	1.25e+001	0.75	1.91e-006	1.91e-005	0.1011	0.05
580	580	5.02e+001	3.76e+001	1.25e+001	0.75	1.92e-006	1.92e-005	0.1011	0.05
590	590	5.02e+001	3.76e+001	1.25e+001	0.75	1.92e-006	1.92e-005	0.1011	0.05
600	600	5.02e+001	3.76e+001	1.25e+001	0.75	1.92e-006	1.92e-005	0.1011	0.05
610	610	5.02e+001	3.76e+001	1.25e+001	0.75	1.92e-006	1.92e-005	0.1012	0.05
620	620	5.02e+001	3.76e+001	1.25e+001	0.75	1.92e-006	1.92e-005	0.1012	0.05
630	630	5.02e+001	3.76e+001	1.25e+001	0.75	1.92e-006	1.92e-005	0.1012	0.05
640	640	5.02e+001	3.76e+001	1.25e+001	0.75	1.92e-006	1.92e-005	0.1012	0.05
650	650	5.02e+001	3.76e+001	1.25e+001	0.75	1.92e-006	1.92e-005	0.1012	0.05
660	660	5.02e+001	3.77e+001	1.26e+001	0.75	1.92e-006	1.92e-005	0.1013	0.05
670	670	5.02e+001	3.77e+001	1.26e+001	0.75	1.92e-006	1.92e-005	0.1013	0.05
680	680	5.02e+001	3.77e+001	1.26e+001	0.75	1.92e-006	1.92e-005	0.1013	0.05
690	690	5.02e+001	3.77e+001	1.26e+001	0.75	1.92e-006	1.92e-005	0.1013	0.05
700	700	5.02e+001	3.77e+001	1.26e+001	0.75	1.92e-006	1.92e-005	0.1013	0.05
710	710	5.02e+001	3.77e+001	1.26e+001	0.75	1.92e-006	1.92e-005	0.1014	0.05
720	720	5.02e+001	3.77e+001	1.26e+001	0.75	1.92e-006	1.92e-005	0.1014	0.05
730	730	5.02e+001	3.77e+001	1.26e+001	0.75	1.92e-006	1.92e-005	0.1014	0.05
740	740	5.02e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1014	0.05

750	750	5.02e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1014	0.05
760	760	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1014	0.05
770	770	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1015	0.05
780	780	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1015	0.05
790	790	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1015	0.05
800	800	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1015	0.05
810	810	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1015	0.05
820	820	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1016	0.05
830	830	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1016	0.05
840	840	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1016	0.05
850	850	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1016	0.05
860	860	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1016	0.05
870	870	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1017	0.05
880	880	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1017	0.05
890	890	5.03e+001	3.77e+001	1.26e+001	0.75	1.93e-006	1.93e-005	0.1017	0.05
900	900	5.03e+001	3.77e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1017	0.05
910	910	5.03e+001	3.77e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1017	0.05
920	920	5.03e+001	3.77e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1018	0.05
930	930	5.03e+001	3.78e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1018	0.05
940	940	5.03e+001	3.78e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1018	0.05
950	950	5.03e+001	3.78e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1018	0.05
960	960	5.03e+001	3.78e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1018	0.05
970	970	5.04e+001	3.78e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1019	0.05
980	980	5.04e+001	3.78e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1019	0.05
990	990	5.04e+001	3.78e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1019	0.05
1000	1000	5.04e+001	3.78e+001	1.26e+001	0.75	1.94e-006	1.94e-005	0.1019	0.05

End of pc-CRACK Output

Revision	0	1	2	
Preparer/Date	HLG 2/17/04	HLG 5/12/04	HLG 5/15/04	
Checker/Date	GLS 2/17/04	MQ 5/12/04	PCR 5/15/04	