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PROJECT NAME:
Contingency Flaw Evaluation Support for Perry

CONTRACT NO.:
55108513

CLIENT:	**PLANT:**
FirstEnergy Nuclear Operating Co.	**Perry Nuclear Power Plant**

CALCULATION TITLE:
Evaluation of fabrication defects in N6A and C nozzle to safe end welds

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1.0 INTRODUCTION/STATEMENT OF PROBLEM/ OBJECTIVE

The N6 A, B, and C nozzle to safe end welds at Perry are dissimilar metal welds connecting the low alloy steel nozzle forgings to the Alloy 600 safe ends. The welds are Alloy 82/182 weld metal [2,5]. These welds were last ultrasonically inspected in 2001, and all results were acceptable per IWB-3500 criteria, requiring no further evaluation. Data from that inspection was re-examined in September, 2008, in preparation for the upcoming refueling outage (February, 2009). This re-examination of the earlier data identified three flaw indications (two in the N6-A weld and one in the N6-C weld) which were determined to slightly exceed the flaw acceptance standards of IWB-3514-2 [1,3]. All of these flaw indications were determined to be subsurface indications with no connection to the inside surface of the welds. All were classified as fabrication-related defects.

The purpose of this calculation is to evaluate the identified flaw indications per the requirements of IWB-3600, to demonstrate that these indications do not affect the structural adequacy of the nozzle to safe end welds.

2.0 TECHNICAL APPROACH OR METHODOLOGY

A fracture mechanics-based evaluation of the flaws is performed per the requirements of IWB-3600. The observed flaws are assumed to have been growing by a fatigue crack growth mechanism since the previous inspection in 2001. The resulting flaws after projected growth to the next refueling outage are evaluated to demonstrate that all structural criteria are maintained.

3.0 ASSUMPTIONS / DESIGN INPUTS

1. A composite flaw was assumed, combining the greatest length, greatest through-wall dimension, and greatest eccentricity of any of the three reported flaws. This hypothetical flaw conservatively bounds the evaluation of all three reported flaws.

2. In a previous calculation performed by SI [2], finite element analysis of the nozzle-safe end welds was performed to determine the weld residual stresses present in the welds following the application of a mechanical stress improvement process (MSIP) in 1992. The bounding residual stress distribution is shown in Figure 1, taken from [2]. Note that in that distribution, the residual stress following MSIP varies from compressive to tensile through the thickness of the weld. In the present calculation, the weld residual stress is conservatively taken to be the maximum tensile from that distribution, and is considered to be a constant membrane stress across the weld thickness. Note that weld residual stress is a steady state secondary stress which is not limited by the ASME Code. In a fatigue crack growth calculation such as that which follows, residual stress acts only as a mean stress, since its magnitude does not cycle with time.

3. The N6 nozzles are assumed to experience stress cycles due to plant start-ups and shut downs, and due to system operation in the RHR mode. RHR cycles are assumed to occur twice as frequently as

start-up/shut down cycles, and to have the same magnitude. Over the eight year period from 2001 until the next refueling outage in 2009, the estimated number of such combined cycles is assumed to be less than 100 (49 cycles reported through April 2008 [6]).

4. Crack growth is calculated from 2001 until the next refueling outage, at which time the N6 nozzles with reported flaw indications will be re-examined.

5. In the following, all applied stresses are modeled as membrane stresses (i.e., constant magnitude across the wall thickness). This is very conservative since the stress combination PL+PB+Q includes significant bending stresses in the PB and Q terms, and treating bending stresses as membrane is conservative.

6. Since all reported flaws are subsurface with no connection to the weld inside surface or to the coolant chemistry, the intergranular stress corrosion crack (IGSCC) growth mechanism is not active. This mechanism requires reactor water chemistry to be present in the crack.

7. The fatigue crack growth law for Austenitic material in Air was taken from ASME Section XI, Appendix C [1]. Since the flaws are subsurface and not wetted, the air law is appropriate.

4.0 FLAW CHARACTERIZATION

There are three subsurface flaws requiring further evaluation [3]. Two of these are located in the N6A weld, and one is located in the N6C weld. These flaws are characterized as follows:
Flaw 1 (N6A): Length: 1.4", Through wall dimension: 0.35", Separation from outside surface: 0.2"

Flaw 2 (N6A): Length:1.0", Through wall dimension: 0.3", Separation from outside surface: 0.4"

Flaw 3 (N6C): Length:11", Through wall dimension: 0.3", Separation from outside surface: 0.4"

The inspection summary sheets from [3] are attached.

5.0 CALCULATIONS

The SI fracture mechanics program pc-CRACK [4] was used to perform the crack growth calculations. The bounding flaw from the flaw characterizations above (see assumption 1) was taken as: Length:11", Through wall dimension: 0.35", Separation from outside surface: 0.2".

This flaw was used as the starting point for the fatigue crack growth calculation. The center-cracked plate model was used to represent the flaw geometry for the crack growth calculation. This is illustrated in Figure 2.

Reference [5 page 2] gives the maximum stresses experienced at the weld as PL+PB+Q=55.03 ksi for the Inconel material. This is conservatively used to bound the stress magnitude associated with the startup-shutdown and RHR cycles.

For the purposes of the fatigue crack growth calculation, the Kmax is taken as {PL+PB+Q+RESIDUAL} and the Kmin is taken as RESIDUAL. Consistent with assumption 5, all stresses are conservatively treated as membrane stresses.

The pc-CRACK crack growth results are shown in Figure 3, and the output is included in Appendix C. It may be seen from these results that for the anticipated number of bounding cycles expected to occur from 2001 to February 2009, only a minimal amount of growth is predicted to occur, even under the very conservative set of assumptions contained herein. The resulting throughwall dimension of the bounding flaw after 100 cycles is 0.366", corresponding to less than 0.02" growth. This meets the acceptance criteria of IWB-3641 [1].

6.0 STRUCTURAL EVALUATION

The presence of flaws will reduce the amount of wall thickness in the weld that is available to carry load. The existing flaws in nozzle N6A have areas of: Flaw 1: Length (1.4) x Throughwall dimension (0.35) = 0.49 in^2; Flaw 2: Length (1.0) x Throughwall dimension (0.3) = 0.3 in^2. The combined area is 0.79 in^2. The flaw in N6C has an area of 11 x 0.3 = 3.3 in^2

The cross sectional area of the weld without flaws is $A=\pi(OR^2-IR^2)=\pi(49.87-33.78)=50.56$ in^2 [7]. So the reported flaws in N6A represent less than 1% of the total area of the weld. The flaw in N6C represents 6.5% of the total area. Removing that amount of material in either weld would increase the stress in the remaining material by the same %. All ASME Allowable stress limits as reported in [5] continue to be met after projected flaw growth.

7.0 CONCLUSIONS AND DISCUSSIONS

The presence of the three reported subsurface fabrication defects and their projected growth due to fatigue does not reduce the capacity of the welds in N6A and C below Code allowable. All Code margins are maintained.

8.0 REFERENCES

1. ASME Section XI, 1989 Edition and 2001 Edition with Addenda through 2003
2. SI Calculation 0800439.306R0, Residual Heat Removal/Low Pressure Core Injection (RHR/LPCI) Nozzle, N6, ID Repair Weld Residual + MSIP Analysis
3. GE Flaw Inspection Reports. SI File 0800439.215
4. SI Program "**pc-CRACK for Windows**", version 3.1-98348
5. CB&I Stress Report "238" BWR Vessel" Section S-13 sheet 2. SI File Number 0800439.216

6. E-mail transmittal from D. Patten (First Energy) to Hal Gustin (SI) "Reactor and Recirculation Pipe Heat-Up,Cool Down and Transient History", October 2, 2008 SI File 0800439.214
7. CB&I Drawing N6 Nozzle Forging (RHR-LPCI MODE)," CBI VPF No. 3521-257, Rev. 1, June 1973 SI File 0800439.208

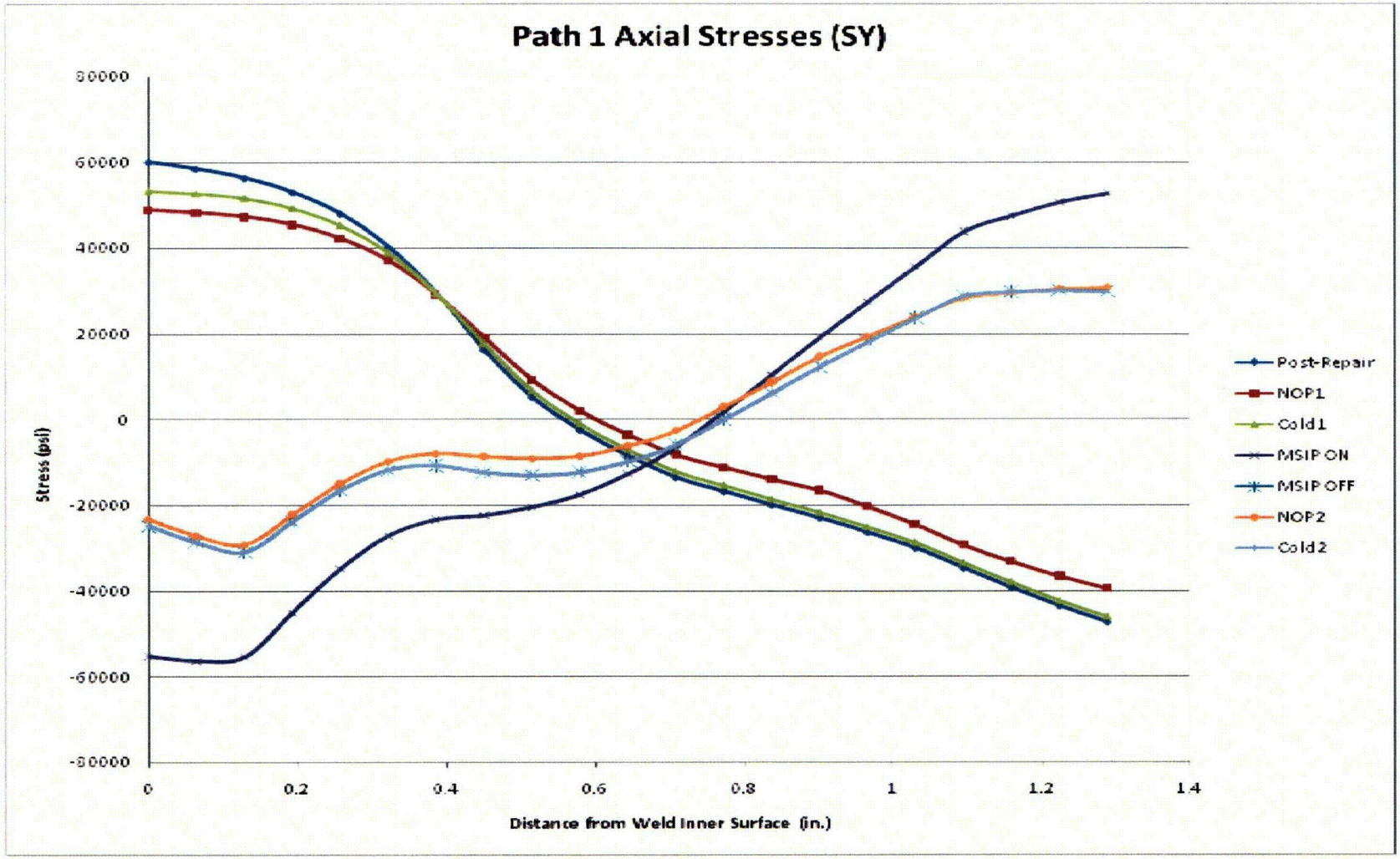
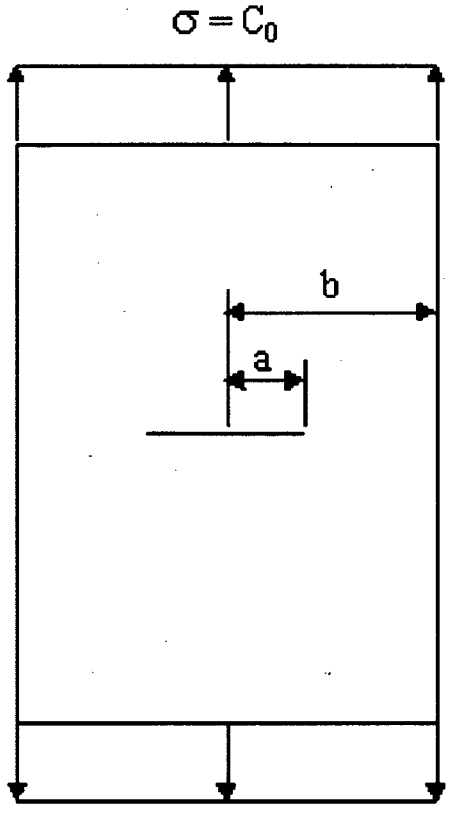


Figure 1. Path 1 Through-Wall Axial Stress (psi)



REQUIRED INPUTS:
b: plate half width
a: maximum crack depth ($a_{max} \leq 0.9b$)

Figure 2. Center-Cracked Plate Fracture Mechanics Model

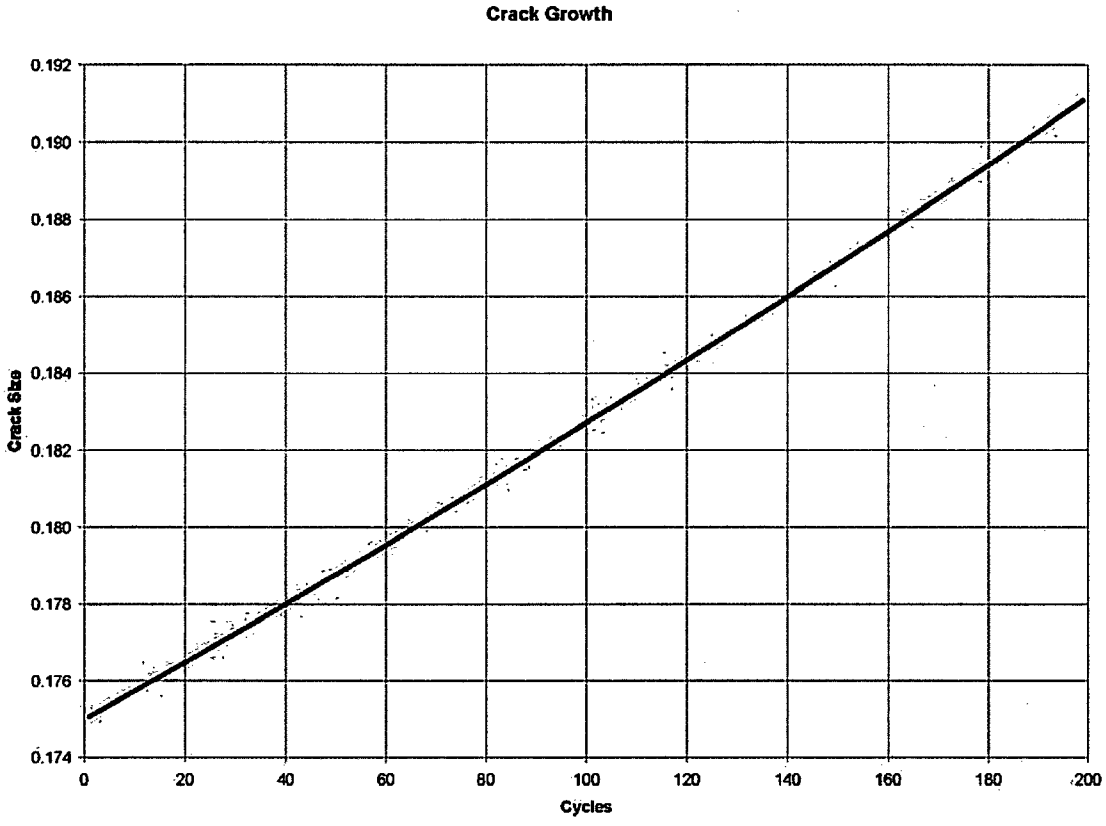


Figure 3. Crack Growth Through 200 Cycles

APPENDIX A

PERRY PLANT CYCLE RECORDS (FROM [6])

TABLE 1
Reactor and Recirculation Pipe Heat-Up,
Cool Down and Transient History

Date	Event	FCR/CR Number	Measurement Location	Rate of change in temperature	Comment
8/3/1986	CD	CR-86-0740	BHDN	-152(°F/hr)	Event occurred during non-nuclear heat up with reactor pressure at 760 psig. Bottom head drain temperature recorded at 424 degrees F @ 1730 hours and 272 degrees F @1830 hours.
2/13/1987	CD	FCR-06012	BHDN	-190(°F/hr)	Observed cooldown rate was in the bottom head drain. Condition enveloped by loss of feedwater event of -200 deg. F/hr
3/2/1987	CD	FCR-06128 CR-87-0111 CR-87-0109	BHDN/CRDN	-180(°F/hr)	Post scram issue, bottom head drain, Recirculation pumps off.
6/17/1987	CD	FCR-07036 CR-87-0294	BHDN/CRDN	-160(°F/hr)	Bottom head drain experienced a cooldown rate of 160 deg, F. Recirculation pumps were secured prior to the scram with RWCU isolated stratification to occurred,
10/27/1987	CD	FCR-08103	BHDN/CRDN	-230(°F/hr)	Bottom head drain
10/27/1987	HU	FCR-08103	BHDN/CRDN	130(°F/hr)	Bottom head drain
11/16/1987	CD	FCR-08264	BHDN/CRDN	-163(°F/hr)	Bottom head drain
1/29/1988	HU	CR-88-0049 FCR-08944	BHDN/CRDN	290(°F/hr)	Bottom head drain. Hot startup RWCU to normal recirculation mode.
3/10/1988	CD	CR-88-0069 FCR-09324	BHDN/CRDN	-105(°F/hr)	Bottom head drain. Reactor water clean up isolation.
3/11/1988	HU	CR-88-0069 FCR-09324	BHDN/CRDN	180(°F/hr)	Bottom head drain. Reactor water clean up isolation.
4/28/1988	CD	FCR-09669	BHDN/CRDN	-240(°F/hr)	Bottom head drain. GE recommended using the ERIS trend plot for temperature data.

TABLE 1
Reactor and Recirculation Pipe Heat-Up,
Cool Down and Transient History

Date	Event	FCR/CR Number	Measurement Location	Rate of change in temperature	Comment
4/28/1988	HU	FCR-09669	BHDN/CRDN	110(°F/hr)	Bottom head drain
6/8/1988	HU	FCR-09953	Recirculation pipe	128(°F/hr)	Started Recirculation pump B temperature change over a one hour period
1/7/1990	CD	FCR-13498	Vessel bulk temperature	-114(°F/hr)	Scram event 01-90-01. Based on ERIS reactor vessel temperature.
1/7/1990	HU	FCR-13498	Vessel bulk temperature	106(°F/hr)	Scram event 01-90-01
1/3/1992	HU	CR-92-001	Main Steam Piping	175(°F/hr)	Downstream of inboard MSIVs
9/11/1992	CD	PIF-97-1280 LER 97-008	All Components	-110(°F/hr)	Bottom head (excluding drain temperature). Recirculation piping remained within limits. Does not include bottom head drain.
	HU			≤100(°F/hr)	
9/11/1992	CD	PIF-97-1280	BHDN	-245(°F/hr)	RWCU isolation
	HU			235(°F/hr)	
03/26/93	CD	97-1280	BHDN	-220 (°F/hr)	115 from page 8 of PIF for one hour period.
	HU			115(°F/hr)	
09/01/95	CD	FCR-21634 PIF-95-1721	Recirculation system	See text	Reactor scram, HPCS & RCIC injection until FW motor driven feed pump started. Natural recirculation flow in recirculation piping. ERIS data with wide range instruments. Loop A, 550 to 350 degrees F in 2 minutes and 350 to 225 degrees F in 1 hour. Loop B drops from 550 to 350 degrees F in 0 minutes, Heats up 350 to 425 degrees F in 20 minutes, drops from 425 to 200 degrees F in 1 hr 50 minutes.

TABLE 1
Reactor and Recirculation Pipe Heat-Up,
Cool Down and Transient History

Date	Event	FCR/CR Number	Measurement Location	Rate of change in temperature	Comment
01-07-97	CD	PIF-97-0017	All Components	-346(°F/hr)	Loss of feedwater. Recirculation pumps shifted to slow speed. Scram on low level 3. RCIC and HPCS initiated at level 2. Water level maintained between level 8 and normal for event. Natural circulation occurs at 5 – 20 inches above normal operating water level. GE-NE-B13-01805-142. The -346 degrees F is from B33 Loop A Page 2 of CR between 0730 and 0830 hrs. Natural recirculation flow. A cyclic condition exists in the recirculation pipe. An intermediate cooldown rate observed in loop A between 07:045 and 07-48 was (530 - 280) / 3 minutes = 83.3 degrees F/min. reference ERIS output page 475 through 477.
06/05/97 Transformer outage	CD	N/A	All Components	<100 (°F/hr)	(Cycle 6-3 end) Cooldown monitored by SVI-B21-T1176 dated 6-9-97 with no discrepancies identified.
9/14/97 Refuel - 6	CD	N/A	All Components	<100 (°F/hr)	(Cycle 6-4 end) Cooldown monitored by SVI-B21-T1176 dated 9/13/97 with no discrepancies identified
12/19/97 Loss of electro-hydraulic control (N32)	CD	N/A	All Components	<100 (°F/hr)	(Cycle 7-1 end) Cooldown monitored by SVI-B21-T1176 dated 12/21/97 with no discrepancies identified. Recirculation pipe and bottom head stayed above 400 deg. F. No SRV actuations, no MSIV closure, no ECCS injection.
07-01-98 Inadvertent RCIC Injection	CD	CR-98-1421	BHDN	-32 (°F/min) 40 (°F/min)	(Cycle 7-2) Following a scram, bottom head drain cooled down then heated back up. SVI-B21-T1176 dated 7/2/98 indicated vessel maintained above 400 degrees.
03/27/99 Refuel Outage 7	CD	N/A	All Components	<100 (°F/hr)	(Cycle 7-3 end) SVI-B21-T1176 dated 3/27/99 review.

TABLE 1
Reactor and Recirculation Pipe Heat-Up,
Cool Down and Transient History

Date	Event	FCR/CR Number	Measurement Location	Rate of change in temperature	Comment
06/04/00 Fuel defect Outage	CD	N/A	All components	<100 (°F/hr)	(Cycle 8-1 end) SVI-B21-T1176 dated 6/5/00
02/17/01 Refuel - 8	CD	N/A	All components	<100 (°F/hr)	(Cycle 8-2 end) SVI-B21-T1176 dated 2/19/01
03/22/01 Start up	HU	N/A	All components	<100 (°F/hr)	(Cycle 9-1) SVI-B21-T1176 order 01-006979-000
04/29/01 Stator Water Leak	CD	CR-01-1987	BHDN	>100 (°F/hr)	(Cycle 9-1 end) Manual scram due to loss of main condenser vacuum. Main steam valves closed on loss of vacuum. RCIC in GST to GST mode. HPCS over ridden. Reactor Recirculation pump trips. Severe recirculation pipe transients. SVI-B21-T1176 order 01-008155-000 guidance tracks bulk saturation temperature. Recirculation pipe temperature rates are from PI plot.
		CR-01-1988	Recirculation Pipe	-220 (°F/hr) Loop A +190 (°F/hr) Loop A	
05/05/01 Start up	HU	N/A	All components	<100 (°F/hr)	(Cycle 9-2) SVI –B21-T1176 order 01-8441
05/08/01 Reactor recirculation seal B replacement	CD	N/A	All components	<100 (°F/hr)	(cycle 9-2 end) SVI-B21-T1176 01-008724-000 dated 5/9/01
05/15/01 Start Up	HU	N/A	All components	<100 (°F/hr)	(Cycle 9-3) SVI-B21-T1176 order 01-010571-000
05/21/01 Circ water pump A failure	CD	N/A	All components	<100 (°F/hr)	(Cycle 9-3 end) SVI-B21-T1176 order 01-010778-000
06/2/01 Start up	HU	N/A	All components	<100 (°F/hr)	(Cycle 9-4) SVI-B21-T1176 order 01-011026-000

TABLE 1
Reactor and Recirculation Pipe Heat-Up,
Cool Down and Transient History

Date	Event	FCR/CR Number	Measurement Location	Rate of change in temperature	Comment
07/12/01 Loss of DIV 1A Unplanned Power change	CD	CR-01-2717	BHDN	-200 (°F/hr)	(Cycle 9-4 end) Following a scram, bottom head drain cooldown. HPCS and RCIC injecting. No other components noted as affected. Recirculation temperature did not oscillate based on PI data. SVI-B21-T1176 order 01-012464-000
07/17/01 partial heat up	HU	N/A	All components	<100 (°F/hr)	SVI-B21-77176 order 01-012463-000 Heat up terminated at 388 degrees F.
07/30/01 Start up	HU	N/A	All components	<100 (°F/hr)	(Cycle 9-5) SVI-B21-77176 order 01-012800-000
12/15/2001 Auto scram due to Feedwater Level Summer Card	HU/CD	CR-01-4276	BHDN	-257 (°F/hr)	(Cycle 9-5 end) Following a plant scram, RCIC and HPCS injected. Bottom head, Bottom head drain, and recirculation pipe experienced temperature changes in excess of 100 degrees per hour. PI data used to determine maximum rates for recirculation piping. SVI B21-T1176 order 01-018052. Note did not completely cooldown.
			BH	-115 (°F/hr)	
			Loop B	-190 (°F/hr)	
			Loop B	-177 (°F/hr)	
12/18/01 Start up	HU	N/A	All Components	< 100 (°F/hr)	(Cycle 9-6) B21-T1176 order 01-018093-000 Vessel heat up began with shell flange at 410 deg. F.
6/04/02 Turbine Trip exciter ground	CD	N/A	All Components	< 100 (°F/hr)	(Cycle 9-6 end) Operators reduced power to about 25% prior to trip. Steam bypass used. SVI-B21-T1176 noted no abnormal cooldown rates.
06/12/02 Start Up	HU	N/A	All Components	< 100 (°F/hr)	(Cycle 9-7) SVI-B21-T1176 order 02-006681-000
9/22/02 Reactor scram during turbine overspeed test	CD	N/A	All Components	< 100 (°F/hr)	(Cycle 9-7 end) SVI - B21-T1176 order 02-010433-000 noted no abnormal cooldown rates.
10/03/02 Start Up	HU	N/A	All Components	< 100 (°F/hr)	(Cycle 9-8) SVI - B21-T1176 order 02-010919-000
4/05/03 Refuel 10 shutdown	CD	N/A	All Components	< 100 (°F/hr)	(Cycle 9-8 end) SVI - B21-T1176 order 03-003499-000

TABLE 1
Reactor and Recirculation Pipe Heat-Up,
Cool Down and Transient History

Date	Event	FCR/CR Number	Measurement Location	Rate of change in temperature	Comment
5/30/03 start up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 10-1) SVI – B21-T1176 /order 03-5567
8/14/03 Grid Instability shutdown	CD	N/A	Recirculation pipe	< 100 (°F/hr)	(Cycle 10-1 end) SVI – B21-T1176 /order 200047329
8/21/03 Start up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 10-2) SVI – B21-T1176 /order 200047975
10/15/2003 Inadvertent SRV lifts at power	N/A	CR 03-05745	N/A	N/A	No temperature transient for recirculation pipe or vessel..
5/22/04 ESW pump A failure Reactor shutdown	CD	N/A	All components	< 100 (°F/hr)	(Cycle 10-2 end) SVI – B21-T1176 /order 200097558
6/3/04 Start up terminated	HU	N/A	All components	< 100 (°F/hr)	Heat up terminated because of RHR A inoperability SVI – B21-T1176 /order 200099438. Maximum vessel temperature recorded 145 degrees F.
6/7/03 Start up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 10-3) SVI – B21-T1176 /order 200099931.
12/23/04 Reactor Recirc pumps shifted to low speed	CD	CR 04-06763	All components	< 100 (°F/hr)	(Cycle 10-3 end) SVI – B21-T1176 /order 200134592. Following recirc pump shift, reactor scrammed at 2354 hours, level 3. at 2355 hours reactor feed pump turbine tripped on level 8.
12/25/04 Start Up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 10-4) SVI – B21-T1176 /order 200134661. Head flange temperature at start was 385 degrees F
1/06/05 Recirculation pumps downshifted	CD	CR 05-0094	All components	< 100 (°F/hr)	(Cycle 10-4 end) Reactor scram SVI – B21-T1176 /order 200135850. Note this evolution referred to as Cycle 10-5 cooldown.. Manual scram, motor feedpump would not start, RCIC injection.
1/30/05 Start Up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 10-5) SVI – B21-T1176 /order 200139105.

TABLE 1
Reactor and Recirculation Pipe Heat-Up,
Cool Down and Transient History

Date	Event	FCR/CR Number	Measurement Location	Rate of change in temperature	Comment
2/22/05 Shutdown Refuel 10	CD	N/A	All components	< 100 (°F/hr)	(Cycle 10-5 end or Cycle 11 cooldown) tripped main turbine for RFO 10. SVI – B21-T1176 /order 200143104.
5/1/05 Start up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 11-1) SVI – B21-T1176 /order 200149024 and 200149436
5/08/06 B33 hydraulic line leak	N/A	N/A	N/A	N/A	(Cycle 11-1) Turbine trip. Plant maintained at 5% Power
12/13/06 P52 air line rupture	CD	N/A	All components	< 100 (°F/hr)	(Cycle 11-1 ends or cycle 11-2 cooldn) Scram 0354 hours. SVI – B21-T1176 /orders 200244661 and 662.
12/18/06 Start up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 11-2) SVI – B21-T1176 /order 200245021
4/02/07 Refuel 11	CD	CR 07-17349	Recirculation Pipe and other components	< 109 (°F/hr)	(Cycle 11 – 2 ends) SVI – B21-T1176 /order 200258535. Attachment 1 to CR identifies bounding rates.
5/10/07 start up Cycle 12	Heat up	N/A	N/A	< 100 (°F/hr)	(Cycle 12-1) SVI – B21-T1176 /order 200263389
5/12/07 Turbine trip	N/A	N/A	N/A	< 100 (°F/hr)	(Cycle 12-) , not full power, 20% per log entry. Trip at 06:50 hours. No Recirculation temperature changes per PI plot 5/12/07 – 5/14/07
5/13/07 Turbine trip	N/A	N/A	All components	< 100 (°F/hr)	(Cycle 12-) Reactor critical at 08:28 hours. Per PI plot reactor remain critical
5/15/07 Reactor scram	CD	N/A	All components	< 100 (°F/hr)	(Cycle 12- 1 end) 31% power 00:58 hours. FW tuning issues SVI – B21-T1176 /order 200264161
5/17/07 Heat up	Heat up	N/A	All components	<.100 (°F/hr)	(Cycle 12 - 2 begin) SVI – B21-T1176 /order 200264205
5/18/07 Turbine trip	N/A	N/A	All components	< 100 (°F/hr)	(Cycle 12-2) Reactor remains critical no thermal changes to recirculation piping based on PI plot May 18, 2007
6/22/07 FCV lockup	N/A	N/A	All Components	< 100 (°F/hr)	(Cycle 12-2 end) scram at 0329 SVI – B21-T1176 /order 200270642 Vessel maintained at approximately

TABLE 1
Reactor and Recirculation Pipe Heat-Up,
Cool Down and Transient History

Date	Event	FCR/CR Number	Measurement Location	Rate of change in temperature	Comment
					400 degrees
6/24/07 start up	Heat up	N/A	All Components	< 100 (°F/hr).	(Cycle 12-3) SVI – B21-T1176 /order 200270642 Vessel warm up from approximately 400 degrees
6/29/07 B33 motor replacement	CD	N/A	All Components	< 100 (°F/hr).	(Cycle 12-3 end) SVI – B21-T1176 /order 200270642
7/23/07 start up	Heat up	N/A	All Components	< 100 (°F/hr)	(Cycle 12-4) SVI – B21-T1176 /order 200275907
11/28/07 Loss of FW	CD/HU	CR-07-30712	Recirculation pipe BHDN	-268 (°F/hr) Cool down 263 (°F/hr) Heat up +259 (°F/hr)	(Cycle 12-4 end) Scram 0732. Loss of RWCU - no Recirculation flow just natural circulation. Temperatures recorded by wide range instruments, B33 EA091 & 92 Loop A& B respectively. Bottom head drain temperature rate not shown. SVI – B21-T1176 /order 200291795. As noted in the CR attached report 3715-RPT-002, page 12 of 53 strip chart indicates bottom head drain temperature maximum cooldown from approximately 535 to 300 degrees in approximately 45 minutes. SVI Data between 1130-1230 hours indicates +259 degree F per hour heat up when RWCU turned on.
12/06/07 start up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 12- 5)SVI – B21-T1176 /order 200292978
4/4/08 Planned Maintenance outage	CD	N/A	All components	< 100 (°F/hr).	(Cycle 12-5end) Planned shutdown N21F0513A replacement. SVI – B21-T1176 /order 200317962
4/11/08 start up	HU	N/A	All components	< 100 (°F/hr)	(Cycle 12-6) – B21-T1176 /order 200318633 and 318634.

Notes:

1. Highlighted events have recirculation temperature rates exceeding 115 degrees F./hr.

APPENDIX B

INSPECTION SUMMARY SHEETS FROM [3]

eDRF No: 0000-0091-3569 Rev: 0

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project: Perry Unit 1
Weld ID: 1B13-N6A-KB
Indication: 1

Exam Data Sheet: 1Q800-01-021
Sizing Data Sheet: N/A

	Measured	Rounded
Flaw Through Wall =	0.34	0.35
Flaw Length "l" =	1.40	1.4
Surface Separation "S" =	0.21	0.2

	Measured	Rounded
"T" nominal =	1.20	1.2
"T" measured =	1.20	1.2

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	~	~
0.05	10.6	10.6	~	~
0.10	10.9	10.9	10.93	10.93 Y
0.15	11.0	11.0	~	~
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed	Allowed
			10.93	10.93

a = 0.175
a/l value = 0.125 If a/l > .5, then a/l = .5
Y = 1.000 Y = S/a, If Y > 1, then Y = 1

Flaw is Subsurface

Allowed a/t = 10.9%
a/t = 14.6%

Flaw is unacceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 12.7" CW from TDC, 0.2" Upstream from Weld Centerline (Safe-End Side)

Evaluated By: Robert Healey
Level: III Date: 09-13-2008

Reviewed By: _____
Level: _____ Date: _____

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Page 235 of 303.

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project: Perry Unit 1
Weld ID: 1B13-N6A-KB
Indication: 2

Exam Data Sheet: 1Q800-01-021
Sizing Data Sheet: N/A

	Measured	Rounded
Flaw Through Wall =	0.28	0.3
Flaw Length "l" =	1.00	1.0
Surface Separation "S" =	0.40	0.4

	Measured	Rounded
"T" nominal =	1.20	1.2
"T" measured =	1.20	1.2

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	~	~
0.05	10.6	10.6	~	~
0.10	10.9	10.9	~	~
0.15	11.0	11.0	10.98	10.98 Y
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed 10.98	Allowed 10.98

a = 0.150
a/l value = 0.150
Y = 1.000

Flaw is Subsurface

Allowed a/t = 11.0%
a/t = 12.5%

Flaw is unacceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 21.7° CW from TDC, 0.2" Upstream from Weld Centerline (Safe-End Side)

Evaluated By: Robert Healey Reviewed By: _____

Level: III Date: 09-13-2008 Level: _____ Date: _____

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eDRF No: 0000-0091-3569 Rev. 0.

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project : Perry Unit 1
Weld ID : 1B13-N6A-KB
Indication : 3

Exam Data Sheet : 1Q800-01-021
Sizing Data Sheet : N/A

	Measured	Rounded
Flaw Through Wall =	0.17	0.15
Flaw Length "l" =	1.80	1.8
Surface Separation "S" =	0.50	0.5

	Measured	Rounded
"T" nominal =	1.20	1.2
"T" measured =	1.20	1.2

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	10.58	10.58 Y
0.05	10.6	10.6	~	~
0.10	10.9	10.9	~	~
0.15	11.0	11.0	~	~
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed 10.58	Allowed 10.58

a = 0.075
a/l value = 0.042
Y = 1.000

Flaw is Subsurface

Allowed a/t = 10.6%
a/t = 6.3%

Flaw is acceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 37.6" CW from TDC, 0.1" Upstream from Weld Centerline (Safe-End Side)

Evaluated By: Robert Hedley Reviewed By: _____

Level: III Date: 09-13-2008 Level: _____ Date: _____

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eDRF No: 0000-0091-3569 Rev: 0.

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project: Perry Unit 1
Weld ID: 1B13-N6A-KB
Indication: 4

Exam Data Sheet: 1Q800-01-021
Sizing Data Sheet: N/A

	Measured	Rounded
Flaw Through Wall =	0.07	0.05
Flaw Length "l" =	0.80	0.8
Surface Separation "S" =	0.75	0.75

	Measured	Rounded
"T" nominal =	1.20	1.2
"T" measured =	1.20	1.2

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	10.56	10.56 Y
0.05	10.6	10.6	~	~
0.10	10.9	10.9	~	~
0.15	11.0	11.0	~	~
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed 10.56	Allowed 10.56

a = 0.025
a/l value = 0.031
Y = 1.000

Flaw is Subsurface

Allowed a/t = 10.6%
a/t = 2.1%

Flaw is acceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 40.0" CW from TDC, 0.2" Upstream from Weld Centerline (Safe-End Side)

Evaluated By: Robert Healey
Level: III Date: 09-13-2008

Reviewed By: _____
Level: _____ Date: _____

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eDRF No: 0000-0091-3569 Rev. 0

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project: Perry Unit 1
Weld ID: 1B13-N6C-KB
Indication: 1

Exam Data Sheet: 1Q800-01-027
Sizing Data Sheet: N/A

	Measured	Rounded
Flow Through Wall =	0.14	0.15
Flow Length "l" =	0.60	0.6
Surface Separation "S" =	0.58	0.6

	Measured	Rounded
"T" nominal =	1.20	1.2
"T" measured =	1.20	1.2

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	~	~
0.05	10.6	10.6	~	~
0.10	10.9	10.9	10.93	10.93 Y
0.15	11.0	11.0	~	~
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed 10.93	Allowed 10.93

a = 0.075
a/l value = 0.125
Y = 1.000

Flaw is Subsurface.

Allowed a/t = 10.9%
a/t = 6.3%

Flaw is acceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 4:5" CW from TDC, 0.1" Downstream from Weld Centerline (Nozzle Side)

Evaluated By: Robert Healey
Level: III Date: 09-23-2008

Reviewed By: _____
Level: _____ Date: _____

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eDRF No: 0000-0091-3569 Rev. 0

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project: Perry Unit 1
Weld ID: 1B13-N6C-KB
Indication: 2

Exam Data Sheet: 1Q800-01-027
Sizing Data Sheet: N/A

	Measured	Rounded
Flaw Through Wall =	0.19	0.2
Flaw Length "l" =	3.70	3.7
Surface Separation "S" =	0.45	0.45

	Measured	Rounded
"T" nominal =	1.20	1.2
"T" measured =	1.20	1.2

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	10.54	10.54 Y
0.05	10.6	10.6	~	~
0.10	10.9	10.9	~	~
0.15	11.0	11.0	~	~
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed 10.54	Allowed 10.54

a = 0.100
a/l value = 0.027
Y = 1.000

Flaw is Subsurface

Allowed a/t = 10.5%
a/t = 8.3%

Flaw is acceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 8.0" CW from TDC, 0.1" Downstream from Weld Centerline (Nozzle Side)

Evaluated By: Robert Healey Reviewed By: _____

Level: III Date: 09-23-2008 Level: _____ Date: _____

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eDRF No: 0000-0091-3569 Rev. 0

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project: Perry Unit 1
Weld ID: 1B13-N6C-KB
Indication: 3

Exam Data Sheet: 1Q800-01-027
Sizing Data Sheet: N/A

	Measured	Rounded
Flaw Through Wall =	0.31	0.3
Flaw Length "l" =	11.00	11.0
Surface Separation "S" =	0.42	0.4

	Measured	Rounded
"T" nominal =	1.20	1.2
"T" measured =	1.20	1.2

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	10.51	10.51 Y
0.05	10.6	10.6	~	~
0.10	10.9	10.9	~	~
0.15	11.0	11.0	~	~
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed 10.51	Allowed 10.51

a = 0.150
a/l value = 0.014
Y = 1.000

Flaw is Subsurface

Allowed a/t = 10.5%
a/t = 12.5%

Flaw is unacceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 15.1" CW from TDC, at the Weld Centerline

Evaluated By: Robert Healey
Level: III Date: 09-23-2008

Reviewed By: _____
Level: _____ Date: _____

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eDRF No: 0000-0091-3569 Rev: 0

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project: Perry Unit 1
Weld ID: 1B13-N6C-KB
Indication: 4

Exam Data Sheet: 1Q800-01-027
Sizing Data Sheet: N/A

	Measured	Rounded		Measured	Rounded
Flaw Through Wall =	0.24	0.25	*"T" nominal* =	1.20	1.2
Flaw Length "l" =	2.00	2.0	*"T" measured* =	1.20	1.2
Surface Separation "S" =	0.48	0.5			

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	~	~
0.05	10.6	10.6	10.67	10.67 Y
0.10	10.9	10.9	~	~
0.15	11.0	11.0	~	~
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed 10.67	Allowed 10.67

a = 0.125
a/l value = 0.063
Y = 1.000

Flaw is Subsurface

Allowed a/t = 10.7%
a/t = 10.4%

Flaw is acceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 25.2" CW from TDC, 0.1" Upstream from Weld Centerline (Safe-End Side)

Evaluated By: Robert Healey
Level: III Date: 09-23-2008

Reviewed By: _____
Level: _____ Date: _____

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eDRF No. 0000-0091-3569 Rev. 0

HITACHI

Austenitic Piping Flaw Evaluation Sheet

Project: Perry Unit 1
Weld ID.: 1B13-N6C-KB
Indication: 5

Exam Data Sheet: 1Q800-01-027
Sizing Data Sheet: N/A

	Measured	Rounded		Measured	Rounded
Flaw Through Wall =	0.23	0.25	*"T" nominal* =	1.20	1.2
Flaw Length "l" =	1.80	1.8	*"T" measured* =	1.20	1.2
Surface Separation "S" =	0.37	0.35			

ASME Section XI, 1989 Edition, No Addenda
TABLE IWB-3514-2 Austenitic Steels, 1.2 Inch Nominal Thickness - Inservice

a/l	Surface %	Subsurface %	Surface %	Subsurface %
0.00	10.5	10.5	~	~
0.05	10.6	10.6	10.71	10.71 Y
0.10	10.9	10.9	~	~
0.15	11.0	11.0	~	~
0.20	11.3	11.3	~	~
0.25	11.4	11.4	~	~
0.30	11.6	11.6	~	~
0.35	11.8	11.8	~	~
0.40	12.0	12.0	~	~
0.45	12.1	12.1	~	~
0.50	12.3	12.3	~	~
			Allowed 10.71	Allowed 10.71

a = 0.125
a/l value = 0.069
Y = 1.000

Flaw is Subsurface

Allowed a/t = 10.7%
a/t = 10.4%

Flaw is acceptable by Table IWB-3514-2.

Revised: 1/27/06

Comments: ASME Section XI rounding performed in accordance with IWA-3200 and ASTM E29.
Indication is circumferential in orientation.

Flaw is located at 31.9" CW from TDC, 0.1" Upstream from Weld Centerline (Safe-End Side)

Evaluated By: Robert Healey
Level: III Date: 09-23-2008

Reviewed By: _____
Level: _____ Date: _____

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APPENDIX C

PC-CRACK OUTPUT

PLPBQ.OUT
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: Thu Oct 02 13:22:16 2008
Input Data and Results File: PLPBQ.LFM

Title: 0800439: N6 A and C Flaw Evaluation

Load Cases:

Case ID	Stress Coefficients C0	C1	C2	C3	Type
Unit Membrane	10	0	0	0	Coeff
Residual consta	20	0	0	0	Coeff

Through Wall Stresses for Load Cases With Stress Coeff

Wall Depth	Case Unit Membr	Case Residual c
0.0000	10	20
0.0300	10	20
0.0600	10	20
0.0900	10	20
0.1200	10	20
0.1500	10	20
0.1800	10	20
0.2100	10	20
0.2400	10	20
0.2700	10	20
0.3000	10	20

Crack Model: Center Cracked Plate Under Remote Tension Stress

Crack Parameters:
Plate Half Width: 0.6000
Crack depth: 0.3000
Co = Remote Tension Stress
All other stress coefficients are neglected.

Stress Intensity Factor

Crack Size	Case Unit Membr	Case Residual c
0.0060	1.37302	2.74604
0.0120	1.94209	3.88417

Page 1

0.0180	2.37926	4.75853
0.0240	2.74848	5.49695
0.0300	3.07453	6.14906
0.0360	3.37018	6.74036
0.0420	3.64303	7.28605
0.0480	3.89804	7.79608
0.0540	4.13869	8.27738
0.0600	4.36752	8.73503
0.0660	4.58645	9.17291
0.0720	4.79701	9.59403
0.0780	5.00041	10.0008
0.0840	5.19763	10.3953
0.0900	5.38951	10.779
0.0960	5.57675	11.1535
0.1020	5.75995	11.5199
0.1080	5.93964	11.8793
0.1140	6.11628	12.2326
0.1200	6.29028	12.5806
0.1260	6.462	12.924
0.1320	6.63178	13.2636
0.1380	6.79992	13.5998
0.1440	6.96671	13.9334
0.1500	7.1324	14.2648
0.1560	7.29724	14.5945
0.1620	7.46146	14.9229
0.1680	7.62527	15.2505
0.1740	7.78889	15.5778
0.1800	7.95251	15.905
0.1860	8.11632	16.2326
0.1920	8.28053	16.5611
0.1980	8.44531	16.8906
0.2040	8.61084	17.2217
0.2100	8.77732	17.5546
0.2160	8.9449	17.8898
0.2220	9.11379	18.2276
0.2280	9.28416	18.5683
0.2340	9.4562	18.9124
0.2400	9.63009	19.2602
0.2460	9.80602	19.612
0.2520	9.9842	19.9684
0.2580	10.1648	20.3296
0.2640	10.3481	20.6962
0.2700	10.5342	21.0684
0.2760	10.7235	21.4469
0.2820	10.916	21.832
0.2880	11.1121	22.2242
0.2940	11.3121	22.6241
0.3000	11.5161	23.0322

Crack Growth Laws:

Law ID: Sect XI Aus Air
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 = 1.8403e-010
is for the currently selected units of:
force: kip
length: inch
temperature: 550.0000 Fahrenheit

Material Fracture Toughness KIc:

Material ID: Alloy 182

Depth	KIc
0.0000	200.0000
0.5000	200.0000
1.0000	200.0000
1.5000	200.0000

Initial crack size= 0.1750
Max. crack size= 0.3000

Number of blocks= 1
Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
Perry1	200	1	1	Sect XI Aus Air	Alloy 182

Subblock	Kmax Case ID	Kmax Scale Factor	Kmin Case ID	Kmin Scale Factor
Perry1	Residual constant	1.5000	Residual constant	1.5000
	Unit Membrane	5.5000		

Crack growth results:

Total Cycles /Time	Subblock Cycles /Time	Kmax	Kmin	DeltaK	R	DaDn /DaDt	Da	a a/thk
Block: 1								
1	1	6.64e+001	2.34e+001	4.30e+001	0.35	7.39e-005	7.39e-005	0.1751 0.29
2	2	6.65e+001	2.35e+001	4.30e+001	0.35	7.39e-005	7.39e-005	0.1751 0.29
3	3	6.65e+001	2.35e+001	4.30e+001	0.35	7.40e-005	7.40e-005	0.1752 0.29
4	4	6.65e+001	2.35e+001	4.30e+001	0.35	7.41e-005	7.41e-005	0.1753 0.29
5	5	6.65e+001	2.35e+001	4.30e+001	0.35	7.41e-005	7.41e-005	0.1754 0.29
6	6	6.65e+001	2.35e+001	4.30e+001	0.35	7.42e-005	7.42e-005	0.1754 0.29
7	7	6.65e+001	2.35e+001	4.31e+001	0.35	7.43e-005	7.43e-005	0.1755 0.29
8	8	6.66e+001	2.35e+001	4.31e+001	0.35	7.43e-005	7.43e-005	0.1756 0.29
9	9	6.66e+001	2.35e+001	4.31e+001	0.35	7.44e-005	7.44e-005	0.1757 0.29
10	10	6.66e+001	2.35e+001	4.31e+001	0.35	7.45e-005	7.45e-005	0.1757 0.29
11	11	6.66e+001	2.35e+001	4.31e+001	0.35	7.45e-005	7.45e-005	0.1758 0.29
12	12	6.66e+001	2.35e+001	4.31e+001	0.35	7.46e-005	7.46e-005	0.1759 0.29

PLPBQ.OUT

13	13	6.66e+001	2.35e+001	4.31e+001	0.35	7.46e-005	7.46e-005	0.176	0.29
14	14	6.67e+001	2.35e+001	4.31e+001	0.35	7.47e-005	7.47e-005	0.176	0.29
15	15	6.67e+001	2.35e+001	4.31e+001	0.35	7.48e-005	7.48e-005	0.1761	0.29
16	16	6.67e+001	2.35e+001	4.32e+001	0.35	7.48e-005	7.48e-005	0.1762	0.29
17	17	6.67e+001	2.35e+001	4.32e+001	0.35	7.49e-005	7.49e-005	0.1763	0.29
18	18	6.67e+001	2.36e+001	4.32e+001	0.35	7.50e-005	7.50e-005	0.1763	0.29
19	19	6.67e+001	2.36e+001	4.32e+001	0.35	7.50e-005	7.50e-005	0.1764	0.29
20	20	6.68e+001	2.36e+001	4.32e+001	0.35	7.51e-005	7.51e-005	0.1765	0.29
21	21	6.68e+001	2.36e+001	4.32e+001	0.35	7.52e-005	7.52e-005	0.1766	0.29
22	22	6.68e+001	2.36e+001	4.32e+001	0.35	7.52e-005	7.52e-005	0.1766	0.29
23	23	6.68e+001	2.36e+001	4.32e+001	0.35	7.53e-005	7.53e-005	0.1767	0.29
24	24	6.68e+001	2.36e+001	4.32e+001	0.35	7.54e-005	7.54e-005	0.1768	0.29
25	25	6.69e+001	2.36e+001	4.33e+001	0.35	7.54e-005	7.54e-005	0.1769	0.29
26	26	6.69e+001	2.36e+001	4.33e+001	0.35	7.55e-005	7.55e-005	0.1769	0.29
27	27	6.69e+001	2.36e+001	4.33e+001	0.35	7.56e-005	7.56e-005	0.177	0.30
28	28	6.69e+001	2.36e+001	4.33e+001	0.35	7.56e-005	7.56e-005	0.1771	0.30
29	29	6.69e+001	2.36e+001	4.33e+001	0.35	7.57e-005	7.57e-005	0.1772	0.30
30	30	6.69e+001	2.36e+001	4.33e+001	0.35	7.57e-005	7.57e-005	0.1772	0.30
31	31	6.70e+001	2.36e+001	4.33e+001	0.35	7.58e-005	7.58e-005	0.1773	0.30
32	32	6.70e+001	2.36e+001	4.33e+001	0.35	7.59e-005	7.59e-005	0.1774	0.30
33	33	6.70e+001	2.36e+001	4.33e+001	0.35	7.59e-005	7.59e-005	0.1775	0.30
34	34	6.70e+001	2.37e+001	4.34e+001	0.35	7.60e-005	7.60e-005	0.1775	0.30
35	35	6.70e+001	2.37e+001	4.34e+001	0.35	7.61e-005	7.61e-005	0.1776	0.30
36	36	6.70e+001	2.37e+001	4.34e+001	0.35	7.61e-005	7.61e-005	0.1777	0.30
37	37	6.71e+001	2.37e+001	4.34e+001	0.35	7.62e-005	7.62e-005	0.1778	0.30
38	38	6.71e+001	2.37e+001	4.34e+001	0.35	7.63e-005	7.63e-005	0.1779	0.30
39	39	6.71e+001	2.37e+001	4.34e+001	0.35	7.63e-005	7.63e-005	0.1779	0.30
40	40	6.71e+001	2.37e+001	4.34e+001	0.35	7.64e-005	7.64e-005	0.178	0.30
41	41	6.71e+001	2.37e+001	4.34e+001	0.35	7.65e-005	7.65e-005	0.1781	0.30
42	42	6.72e+001	2.37e+001	4.35e+001	0.35	7.65e-005	7.65e-005	0.1782	0.30
43	43	6.72e+001	2.37e+001	4.35e+001	0.35	7.66e-005	7.66e-005	0.1782	0.30
44	44	6.72e+001	2.37e+001	4.35e+001	0.35	7.67e-005	7.67e-005	0.1783	0.30
45	45	6.72e+001	2.37e+001	4.35e+001	0.35	7.67e-005	7.67e-005	0.1784	0.30
46	46	6.72e+001	2.37e+001	4.35e+001	0.35	7.68e-005	7.68e-005	0.1785	0.30
47	47	6.72e+001	2.37e+001	4.35e+001	0.35	7.69e-005	7.69e-005	0.1785	0.30
48	48	6.73e+001	2.37e+001	4.35e+001	0.35	7.69e-005	7.69e-005	0.1786	0.30
49	49	6.73e+001	2.37e+001	4.35e+001	0.35	7.70e-005	7.70e-005	0.1787	0.30
50	50	6.73e+001	2.38e+001	4.35e+001	0.35	7.71e-005	7.71e-005	0.1788	0.30
51	51	6.73e+001	2.38e+001	4.36e+001	0.35	7.71e-005	7.71e-005	0.1789	0.30
52	52	6.73e+001	2.38e+001	4.36e+001	0.35	7.72e-005	7.72e-005	0.1789	0.30
53	53	6.73e+001	2.38e+001	4.36e+001	0.35	7.73e-005	7.73e-005	0.179	0.30
54	54	6.74e+001	2.38e+001	4.36e+001	0.35	7.73e-005	7.73e-005	0.1791	0.30
55	55	6.74e+001	2.38e+001	4.36e+001	0.35	7.74e-005	7.74e-005	0.1792	0.30
56	56	6.74e+001	2.38e+001	4.36e+001	0.35	7.75e-005	7.75e-005	0.1792	0.30
57	57	6.74e+001	2.38e+001	4.36e+001	0.35	7.76e-005	7.76e-005	0.1793	0.30
58	58	6.74e+001	2.38e+001	4.36e+001	0.35	7.76e-005	7.76e-005	0.1794	0.30
59	59	6.75e+001	2.38e+001	4.36e+001	0.35	7.77e-005	7.77e-005	0.1795	0.30
60	60	6.75e+001	2.38e+001	4.37e+001	0.35	7.78e-005	7.78e-005	0.1795	0.30
61	61	6.75e+001	2.38e+001	4.37e+001	0.35	7.78e-005	7.78e-005	0.1796	0.30
62	62	6.75e+001	2.38e+001	4.37e+001	0.35	7.79e-005	7.79e-005	0.1797	0.30
63	63	6.75e+001	2.38e+001	4.37e+001	0.35	7.80e-005	7.80e-005	0.1798	0.30
64	64	6.75e+001	2.38e+001	4.37e+001	0.35	7.80e-005	7.80e-005	0.1799	0.30
65	65	6.76e+001	2.38e+001	4.37e+001	0.35	7.81e-005	7.81e-005	0.1799	0.30
66	66	6.76e+001	2.39e+001	4.37e+001	0.35	7.82e-005	7.82e-005	0.18	0.30
67	67	6.76e+001	2.39e+001	4.37e+001	0.35	7.82e-005	7.82e-005	0.1801	0.30
68	68	6.76e+001	2.39e+001	4.38e+001	0.35	7.83e-005	7.83e-005	0.1802	0.30
69	69	6.76e+001	2.39e+001	4.38e+001	0.35	7.84e-005	7.84e-005	0.1803	0.30
70	70	6.77e+001	2.39e+001	4.38e+001	0.35	7.84e-005	7.84e-005	0.1803	0.30
71	71	6.77e+001	2.39e+001	4.38e+001	0.35	7.85e-005	7.85e-005	0.1804	0.30
72	72	6.77e+001	2.39e+001	4.38e+001	0.35	7.86e-005	7.86e-005	0.1805	0.30
73	73	6.77e+001	2.39e+001	4.38e+001	0.35	7.87e-005	7.87e-005	0.1806	0.30
74	74	6.77e+001	2.39e+001	4.38e+001	0.35	7.87e-005	7.87e-005	0.1806	0.30
75	75	6.77e+001	2.39e+001	4.38e+001	0.35	7.88e-005	7.88e-005	0.1807	0.30

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76	76	6.78e+001	2.39e+001	4.38e+001	0.35	7.89e-005	7.89e-005	0.1808	0.30
77	77	6.78e+001	2.39e+001	4.39e+001	0.35	7.89e-005	7.89e-005	0.1809	0.30
78	78	6.78e+001	2.39e+001	4.39e+001	0.35	7.90e-005	7.90e-005	0.181	0.30
79	79	6.78e+001	2.39e+001	4.39e+001	0.35	7.91e-005	7.91e-005	0.181	0.30
80	80	6.78e+001	2.39e+001	4.39e+001	0.35	7.91e-005	7.91e-005	0.1811	0.30
81	81	6.79e+001	2.39e+001	4.39e+001	0.35	7.92e-005	7.92e-005	0.1812	0.30
82	82	6.79e+001	2.40e+001	4.39e+001	0.35	7.93e-005	7.93e-005	0.1813	0.30
83	83	6.79e+001	2.40e+001	4.39e+001	0.35	7.94e-005	7.94e-005	0.1814	0.30
84	84	6.79e+001	2.40e+001	4.39e+001	0.35	7.94e-005	7.94e-005	0.1814	0.30
85	85	6.79e+001	2.40e+001	4.40e+001	0.35	7.95e-005	7.95e-005	0.1815	0.30
86	86	6.79e+001	2.40e+001	4.40e+001	0.35	7.96e-005	7.96e-005	0.1816	0.30
87	87	6.80e+001	2.40e+001	4.40e+001	0.35	7.96e-005	7.96e-005	0.1817	0.30
88	88	6.80e+001	2.40e+001	4.40e+001	0.35	7.97e-005	7.97e-005	0.1818	0.30
89	89	6.80e+001	2.40e+001	4.40e+001	0.35	7.98e-005	7.98e-005	0.1818	0.30
90	90	6.80e+001	2.40e+001	4.40e+001	0.35	7.99e-005	7.99e-005	0.1819	0.30
91	91	6.80e+001	2.40e+001	4.40e+001	0.35	7.99e-005	7.99e-005	0.182	0.30
92	92	6.81e+001	2.40e+001	4.40e+001	0.35	8.00e-005	8.00e-005	0.1821	0.30
93	93	6.81e+001	2.40e+001	4.41e+001	0.35	8.01e-005	8.01e-005	0.1822	0.30
94	94	6.81e+001	2.40e+001	4.41e+001	0.35	8.02e-005	8.02e-005	0.1822	0.30
95	95	6.81e+001	2.40e+001	4.41e+001	0.35	8.02e-005	8.02e-005	0.1823	0.30
96	96	6.81e+001	2.40e+001	4.41e+001	0.35	8.03e-005	8.03e-005	0.1824	0.30
97	97	6.82e+001	2.41e+001	4.41e+001	0.35	8.04e-005	8.04e-005	0.1825	0.30
98	98	6.82e+001	2.41e+001	4.41e+001	0.35	8.04e-005	8.04e-005	0.1826	0.30
99	99	6.82e+001	2.41e+001	4.41e+001	0.35	8.05e-005	8.05e-005	0.1826	0.30
100	100	6.82e+001	2.41e+001	4.41e+001	0.35	8.06e-005	8.06e-005	0.1827	0.30
101	101	6.82e+001	2.41e+001	4.41e+001	0.35	8.07e-005	8.07e-005	0.1828	0.30
102	102	6.82e+001	2.41e+001	4.42e+001	0.35	8.07e-005	8.07e-005	0.1829	0.30
103	103	6.83e+001	2.41e+001	4.42e+001	0.35	8.08e-005	8.08e-005	0.183	0.30
104	104	6.83e+001	2.41e+001	4.42e+001	0.35	8.09e-005	8.09e-005	0.183	0.31
105	105	6.83e+001	2.41e+001	4.42e+001	0.35	8.10e-005	8.10e-005	0.1831	0.31
106	106	6.83e+001	2.41e+001	4.42e+001	0.35	8.10e-005	8.10e-005	0.1832	0.31
107	107	6.83e+001	2.41e+001	4.42e+001	0.35	8.11e-005	8.11e-005	0.1833	0.31
108	108	6.84e+001	2.41e+001	4.42e+001	0.35	8.12e-005	8.12e-005	0.1834	0.31
109	109	6.84e+001	2.41e+001	4.42e+001	0.35	8.12e-005	8.12e-005	0.1834	0.31
110	110	6.84e+001	2.41e+001	4.43e+001	0.35	8.13e-005	8.13e-005	0.1835	0.31
111	111	6.84e+001	2.41e+001	4.43e+001	0.35	8.14e-005	8.14e-005	0.1836	0.31
112	112	6.84e+001	2.42e+001	4.43e+001	0.35	8.15e-005	8.15e-005	0.1837	0.31
113	113	6.85e+001	2.42e+001	4.43e+001	0.35	8.15e-005	8.15e-005	0.1838	0.31
114	114	6.85e+001	2.42e+001	4.43e+001	0.35	8.16e-005	8.16e-005	0.1839	0.31
115	115	6.85e+001	2.42e+001	4.43e+001	0.35	8.17e-005	8.17e-005	0.1839	0.31
116	116	6.85e+001	2.42e+001	4.43e+001	0.35	8.18e-005	8.18e-005	0.184	0.31
117	117	6.85e+001	2.42e+001	4.43e+001	0.35	8.18e-005	8.18e-005	0.1841	0.31
118	118	6.85e+001	2.42e+001	4.44e+001	0.35	8.19e-005	8.19e-005	0.1842	0.31
119	119	6.86e+001	2.42e+001	4.44e+001	0.35	8.20e-005	8.20e-005	0.1843	0.31
120	120	6.86e+001	2.42e+001	4.44e+001	0.35	8.21e-005	8.21e-005	0.1843	0.31
121	121	6.86e+001	2.42e+001	4.44e+001	0.35	8.21e-005	8.21e-005	0.1844	0.31
122	122	6.86e+001	2.42e+001	4.44e+001	0.35	8.22e-005	8.22e-005	0.1845	0.31
123	123	6.86e+001	2.42e+001	4.44e+001	0.35	8.23e-005	8.23e-005	0.1846	0.31
124	124	6.87e+001	2.42e+001	4.44e+001	0.35	8.24e-005	8.24e-005	0.1847	0.31
125	125	6.87e+001	2.42e+001	4.44e+001	0.35	8.24e-005	8.24e-005	0.1848	0.31
126	126	6.87e+001	2.42e+001	4.45e+001	0.35	8.25e-005	8.25e-005	0.1848	0.31
127	127	6.87e+001	2.43e+001	4.45e+001	0.35	8.26e-005	8.26e-005	0.1849	0.31
128	128	6.87e+001	2.43e+001	4.45e+001	0.35	8.27e-005	8.27e-005	0.185	0.31
129	129	6.88e+001	2.43e+001	4.45e+001	0.35	8.27e-005	8.27e-005	0.1851	0.31
130	130	6.88e+001	2.43e+001	4.45e+001	0.35	8.28e-005	8.28e-005	0.1852	0.31
131	131	6.88e+001	2.43e+001	4.45e+001	0.35	8.29e-005	8.29e-005	0.1853	0.31
132	132	6.88e+001	2.43e+001	4.45e+001	0.35	8.30e-005	8.30e-005	0.1853	0.31
133	133	6.88e+001	2.43e+001	4.45e+001	0.35	8.31e-005	8.31e-005	0.1854	0.31
134	134	6.89e+001	2.43e+001	4.46e+001	0.35	8.31e-005	8.31e-005	0.1855	0.31
135	135	6.89e+001	2.43e+001	4.46e+001	0.35	8.32e-005	8.32e-005	0.1856	0.31
136	136	6.89e+001	2.43e+001	4.46e+001	0.35	8.33e-005	8.33e-005	0.1857	0.31
137	137	6.89e+001	2.43e+001	4.46e+001	0.35	8.34e-005	8.34e-005	0.1857	0.31
138	138	6.89e+001	2.43e+001	4.46e+001	0.35	8.34e-005	8.34e-005	0.1858	0.31

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139	139	6.89e+001	2.43e+001	4.46e+001	0.35	8.35e-005	8.35e-005	0.1859	0.31
140	140	6.90e+001	2.43e+001	4.46e+001	0.35	8.36e-005	8.36e-005	0.186	0.31
141	141	6.90e+001	2.43e+001	4.46e+001	0.35	8.37e-005	8.37e-005	0.1861	0.31
142	142	6.90e+001	2.44e+001	4.47e+001	0.35	8.37e-005	8.37e-005	0.1862	0.31
143	143	6.90e+001	2.44e+001	4.47e+001	0.35	8.38e-005	8.38e-005	0.1863	0.31
144	144	6.90e+001	2.44e+001	4.47e+001	0.35	8.39e-005	8.39e-005	0.1863	0.31
145	145	6.91e+001	2.44e+001	4.47e+001	0.35	8.40e-005	8.40e-005	0.1864	0.31
146	146	6.91e+001	2.44e+001	4.47e+001	0.35	8.41e-005	8.41e-005	0.1865	0.31
147	147	6.91e+001	2.44e+001	4.47e+001	0.35	8.41e-005	8.41e-005	0.1866	0.31
148	148	6.91e+001	2.44e+001	4.47e+001	0.35	8.42e-005	8.42e-005	0.1867	0.31
149	149	6.91e+001	2.44e+001	4.47e+001	0.35	8.43e-005	8.43e-005	0.1868	0.31
150	150	6.92e+001	2.44e+001	4.48e+001	0.35	8.44e-005	8.44e-005	0.1868	0.31
151	151	6.92e+001	2.44e+001	4.48e+001	0.35	8.45e-005	8.45e-005	0.1869	0.31
152	152	6.92e+001	2.44e+001	4.48e+001	0.35	8.45e-005	8.45e-005	0.187	0.31
153	153	6.92e+001	2.44e+001	4.48e+001	0.35	8.46e-005	8.46e-005	0.1871	0.31
154	154	6.92e+001	2.44e+001	4.48e+001	0.35	8.47e-005	8.47e-005	0.1872	0.31
155	155	6.93e+001	2.44e+001	4.48e+001	0.35	8.48e-005	8.48e-005	0.1873	0.31
156	156	6.93e+001	2.45e+001	4.48e+001	0.35	8.49e-005	8.49e-005	0.1873	0.31
157	157	6.93e+001	2.45e+001	4.48e+001	0.35	8.49e-005	8.49e-005	0.1874	0.31
158	158	6.93e+001	2.45e+001	4.49e+001	0.35	8.50e-005	8.50e-005	0.1875	0.31
159	159	6.93e+001	2.45e+001	4.49e+001	0.35	8.51e-005	8.51e-005	0.1876	0.31
160	160	6.94e+001	2.45e+001	4.49e+001	0.35	8.52e-005	8.52e-005	0.1877	0.31
161	161	6.94e+001	2.45e+001	4.49e+001	0.35	8.53e-005	8.53e-005	0.1878	0.31
162	162	6.94e+001	2.45e+001	4.49e+001	0.35	8.53e-005	8.53e-005	0.1879	0.31
163	163	6.94e+001	2.45e+001	4.49e+001	0.35	8.54e-005	8.54e-005	0.1879	0.31
164	164	6.94e+001	2.45e+001	4.49e+001	0.35	8.55e-005	8.55e-005	0.188	0.31
165	165	6.95e+001	2.45e+001	4.49e+001	0.35	8.56e-005	8.56e-005	0.1881	0.31
166	166	6.95e+001	2.45e+001	4.50e+001	0.35	8.57e-005	8.57e-005	0.1882	0.31
167	167	6.95e+001	2.45e+001	4.50e+001	0.35	8.57e-005	8.57e-005	0.1883	0.31
168	168	6.95e+001	2.45e+001	4.50e+001	0.35	8.58e-005	8.58e-005	0.1884	0.31
169	169	6.95e+001	2.45e+001	4.50e+001	0.35	8.59e-005	8.59e-005	0.1885	0.31
170	170	6.96e+001	2.46e+001	4.50e+001	0.35	8.60e-005	8.60e-005	0.1885	0.31
171	171	6.96e+001	2.46e+001	4.50e+001	0.35	8.61e-005	8.61e-005	0.1886	0.31
172	172	6.96e+001	2.46e+001	4.50e+001	0.35	8.61e-005	8.61e-005	0.1887	0.31
173	173	6.96e+001	2.46e+001	4.50e+001	0.35	8.62e-005	8.62e-005	0.1888	0.31
174	174	6.96e+001	2.46e+001	4.51e+001	0.35	8.63e-005	8.63e-005	0.1889	0.31
175	175	6.97e+001	2.46e+001	4.51e+001	0.35	8.64e-005	8.64e-005	0.189	0.31
176	176	6.97e+001	2.46e+001	4.51e+001	0.35	8.65e-005	8.65e-005	0.1891	0.32
177	177	6.97e+001	2.46e+001	4.51e+001	0.35	8.66e-005	8.66e-005	0.1891	0.32
178	178	6.97e+001	2.46e+001	4.51e+001	0.35	8.66e-005	8.66e-005	0.1892	0.32
179	179	6.97e+001	2.46e+001	4.51e+001	0.35	8.67e-005	8.67e-005	0.1893	0.32
180	180	6.98e+001	2.46e+001	4.51e+001	0.35	8.68e-005	8.68e-005	0.1894	0.32
181	181	6.98e+001	2.46e+001	4.52e+001	0.35	8.69e-005	8.69e-005	0.1895	0.32
182	182	6.98e+001	2.46e+001	4.52e+001	0.35	8.70e-005	8.70e-005	0.1896	0.32
183	183	6.98e+001	2.46e+001	4.52e+001	0.35	8.71e-005	8.71e-005	0.1897	0.32
184	184	6.98e+001	2.47e+001	4.52e+001	0.35	8.71e-005	8.71e-005	0.1898	0.32
185	185	6.99e+001	2.47e+001	4.52e+001	0.35	8.72e-005	8.72e-005	0.1898	0.32
186	186	6.99e+001	2.47e+001	4.52e+001	0.35	8.73e-005	8.73e-005	0.1899	0.32
187	187	6.99e+001	2.47e+001	4.52e+001	0.35	8.74e-005	8.74e-005	0.19	0.32
188	188	6.99e+001	2.47e+001	4.52e+001	0.35	8.75e-005	8.75e-005	0.1901	0.32
189	189	6.99e+001	2.47e+001	4.53e+001	0.35	8.76e-005	8.76e-005	0.1902	0.32
190	190	7.00e+001	2.47e+001	4.53e+001	0.35	8.76e-005	8.76e-005	0.1903	0.32
191	191	7.00e+001	2.47e+001	4.53e+001	0.35	8.77e-005	8.77e-005	0.1904	0.32
192	192	7.00e+001	2.47e+001	4.53e+001	0.35	8.78e-005	8.78e-005	0.1905	0.32
193	193	7.00e+001	2.47e+001	4.53e+001	0.35	8.79e-005	8.79e-005	0.1905	0.32
194	194	7.00e+001	2.47e+001	4.53e+001	0.35	8.80e-005	8.80e-005	0.1906	0.32
195	195	7.01e+001	2.47e+001	4.53e+001	0.35	8.81e-005	8.81e-005	0.1907	0.32
196	196	7.01e+001	2.47e+001	4.54e+001	0.35	8.81e-005	8.81e-005	0.1908	0.32
197	197	7.01e+001	2.47e+001	4.54e+001	0.35	8.82e-005	8.82e-005	0.1909	0.32
198	198	7.01e+001	2.48e+001	4.54e+001	0.35	8.83e-005	8.83e-005	0.191	0.32
199	199	7.01e+001	2.48e+001	4.54e+001	0.35	8.84e-005	8.84e-005	0.1911	0.32
200	200	7.02e+001	2.48e+001	4.54e+001	0.35	8.85e-005	8.85e-005	0.1912	0.32