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RS-09-158

November 16, 2009

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Dresden Nuclear Power Station, Unit 2
Renewed Facility Operating License No. DPR-19
NRC Docket No. 50-237

Subject: Request for Approval of Pipe Flaw Evaluation

References:
(1) NRC Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," dated January 25, 1988

(2) Letter from B. Rybak (Commonwealth Edison Company) to U.S. NRC, "Dresden Nuclear Power Station Unit 2 Recirculation System and Reactor Head Flaw Indication Evaluations," dated October 16, 1995

(3) Letter from J. Stang (U.S. NRC) to D. Farrar (Commonwealth Edison Company), "Dresden, Unit 2, Flaw Evaluations (TAC No. M93862)," dated February 15, 1996

In accordance with Generic Letter (GL) 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," dated January 25, 1988 (i.e., Reference 1), Exelon Generation Company, LLC (EGC) requests NRC approval of a pipe flaw evaluation for a weld in the Reactor Recirculation (RR) system piping at Dresden Nuclear Power Station (DNPS), Unit 2 that EGC proposes to leave as-is without repair. The flaw indication does not meet the acceptance standards of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Section XI, 1995 Edition with 1996 Addenda, which is the DNPS Unit 2 Section XI code of record for the current fourth inspection interval, for continued operation without repair/replacement or flaw evaluation.

On November 08, 2009, during the current DNPS Unit 2 refueling outage (i.e., D2R21), EGC identified a change in depth of a previously known circumferential flaw indication. The inspections were conducted in accordance with Reference 1 and Boiling Water Reactor Vessel and Internals Project (BWRVIP) Report 75-A, "Technical Basis for Revisions to Generic Letter 88-01 Inspection Schedules," dated October 2005. The UT examination used Performance Demonstration Initiative (PDI) qualified personnel, equipment, and procedures. The circumferential flaw indication is in weld PD1A-D14, which is a Category "F" weld, and is located on the pipe/downstream side of a 28-inch diameter "A" Recirculation Pump discharge

elbow-to-pipe weld. There are no axial flaw indications detected in this weld. The pipe material is SA358-304; the elbow material is SA403-WP304, with a nominal pipe wall thickness of 1.375 inches. The length of the flaw indication is 1.00 inch and the through-wall depth, measured from the inside diameter, is 0.32 inches. The last examination of this weld was performed in November 2007, also using PDI qualified personnel, equipment, and procedures, and the recorded measurements were 1.00 inch in length and the through-wall depth was measured as 0.25 inches.

The circumferential flaw indication has been observed on this weld since 1986. Reference 2 provided the original flaw evaluation, which was performed when it was determined at the time (i.e., 1995) that the flaw indication was deeper than the previously measured depth. The original flaw evaluation was subsequently approved as documented in Reference 3.

DNPS Unit 2 has a total of three (3) Category "F" welds and all three Category "F" welds have been inspected in D2R21, therefore, sample inspection expansion is not necessary.

An evaluation of the circumferential flaw indication assuming conservative crack growth rates has been performed by Structural Integrity Associates, Inc. and is attached to this letter. The evaluation was performed using the methodology and acceptance criteria specified in ASME Code, Section XI, 1995 Edition with 1996 Addenda, subarticle IWB-3640, "Evaluation Procedures and Acceptance Criteria for Austenitic Piping," and the guidance of NUREG-0313, Revision 2, "Technical Report on Material Selection and Process Guidelines for BWR Coolant Pressure Boundary Piping." This flaw evaluation considered a conservative flaw size, expected growth rates assuming hydrogen water chemistry and plant chemistry parameters. It demonstrates that substantial structural margin exists for more than one operating cycle considering water chemistry, since the acceptance criteria of subarticle IWB-3640 are met.

In accordance with the ultrasonic examination report, included as Appendix B to the attached flaw evaluation, the flaw indication is located on the pipe/downstream side at 32.5 inches clockwise azimuthally. The axial scan on the elbow/upstream side is limited from 26 inches to 70 inches clockwise azimuthally due to a whip restraint, which resulted in 51% axial scan coverage on the elbow/upstream side. The axial scan on the pipe/downstream side, where the flaw indication is located, and the circumferential scans on both sides of the weld achieved 100% coverage. The total cumulative examination coverage for the weld is 87.75%. Sizing of the flaw indication was not impeded by the presence of the whip restraint because the sizing procedure used is qualified for sizing from the side where the flaw indication is located. Given that at the end of the evaluation period, a 360 degree flaw would still be below the IWB-3641 allowable flaw depth of about 60%, the small percent of unexamined volume does not materially impact the conclusions of the Structural Integrity Associates evaluation.

Therefore, EGC has concluded that the flaw indication is acceptable as-is for continued operation through the next operating cycle. Weld PD1A-D14 classification will remain as category "F" (i.e., cracked weld with inadequate or no repair) and will require inspection each subsequent refueling outage.

EGC requests NRC review and approval of the attached flaw evaluation report by November 25, 2009, in support of unit startup.

Should you have questions concerning this submittal, please contact Mr. Timothy Byam at (630) 657-2804.

Respectfully,

Jeffrey L. Hansen
Manager – Licensing

Attachment: Structural Integrity Associates, Inc. Report, "Crack Growth Analysis for Weld PD1A-D14," File No.: 0901309.302

ATTACHMENT

Structural Integrity Associates, Inc. Report,

"Crack Growth Analysis for Weld PD1A-D14,"

File No.: 0901309.302

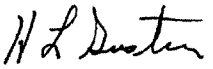
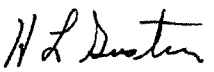
Structural Integrity Associates, Inc. **CALCULATION PACKAGE**	**File No.: 0901309.302** **Project No.: 0901309** Quality Program: ☒ Nuclear ☐ Commercial

PROJECT NAME:
Dresden Unit 2 Recirculation Line Flaw Evaluation

CONTRACT NO.:
Requisition 1094921 Exelon GSA 441728

CLIENT:	**PLANT:**
Exelon	Dresden Generating Station, Unit 2

CALCULATION TITLE:
Crack Growth Analysis for Weld PD1A-D14

Document Revision	Affected Pages	Revision Description	Project Manager Approval Signature & Date	Preparer(s) & Checker(s) Signatures & Date
0	1 - 7 A-1 – A-7 B-1 – B-9 C-1 – C-3	Initial Issue	 H. L. Gustin 11/15/09	 H. L. Gustin Preparer 11/15/09 Daniel V. Sommerville Independent Verifier 11/15/09

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1.0 INTRODUCTION/OBJECTIVE

The purpose of this calculation is to update the evaluation of a flaw indication observed in Weld PD1A-D14, located in the Dresden Generating Station Unit 2 Reactor Recirculation System piping, to account for changes in its input data that have occurred since it was originally performed in 1995 [2]. An ultrasonic examination of the weld was performed during outage D2R21, which identified one indication requiring evaluation. This indication was also identified during the previous inspection. Also, Dresden's committed Edition of ASME Boiler & Pressure Vessel Code Section XI, which governs the evaluation has changed, and the piping analysis of the Reactor Recirculation System has been revised. The evaluation that follows incorporates these changes to the input data. The evaluation applies linear elastic fracture mechanics (LEFM) establish a conservative estimate of the growth of the flaw. Both fatigue crack growth (FCG) and Intergranular Stress Corrosion Cracking (IGSCC) are considered.

2.0 METHODOLOGY

The allowable end-of-evaluation period flaw depth to thickness ratio (a/t) was taken from Table IWB-3641-1, which is derived by the methodology of Appendix C of ASME Code, Section XI [3].
The geometry and design pressure for Weld PD1A-D14 is summarized below.

A conservative estimate of crack growth is computed using linear elastic fracture mechanics (LEFM) techniques. Both fatigue crack growth (FCG) and Intergranular Stress Corrosion Cracking (IGSCC) are considered. The time for the observed flaw to grow to the Section XI IWB-3641-1 allowable depth is determined.

The fatigue crack growth (FCG) analysis was performed using the LEFM analysis option in **pc-CRACK for Windows™** software [4]. This software includes options for the evaluation of FCG, and allows for defining load cases, material properties, crack models, and the selection of the applicable crack growth law. FCG results are summarized in Section 5.1. The IGSCC growth calculation follows in Section 5.2. Appendix A contains **pc-CRACK** output of the FCG growth analysis.

3.0 DESIGN INPUTS

3.1 Materials and Geometry

The dimensions of Weld PD1A-D14 are described below. These are taken from the Inspection Report [5].

Material:	SA358 Type 304 Austenitic Stainless Steel
Outside diameter:	OD = 28 inches
Wall Thickness:	t = 1.375 inch

A copy of the examination report is enclosed in Appendix B. The NDE inspection report [5] identifies one reportable indication, circumferentially oriented on the pipe side of the weld. Reported dimensions are: Length = 1.0 inch, depth = 0.32 inch, at the ID surface.

Flaw Length to Pipe Circumference Ratio:	0.01
Table IWB 3641.1 Allowable Depth to Wall Thickness (a/t) Ratio:	0.75
Measured Flaw Depth to Wall Thickness (a/t) Ratio:	0.24

Per the inspection report [5], the flaw is located at 32.5 inches clockwise azimuthally. One axial scan achieved limited coverage (from 26.0 inches to 70.0 inches azimuthally) due to the welded restraint. The other axial scan and both circumferential scans achieved 100% coverage. Inspection of the flaw location was not limited.

3.2 Loading

Loads considered in this evaluation are taken from [1] and [2]. These affect only the fatigue crack growth portion of the present calculation, since a constant (K-independent) IGSCC crack growth correlation is used as described below. Stresses considered in the fatigue crack growth calculation include pressure, deadweight (not cyclic, but conservatively included with pressure in equation 8 calculations in [1]), and thermal cycling, taken from [2]. Appendix D of [1] reports stresses at the top ten locations for each load combination (equation). The highest value reported for equation 8 (design pressure plus dead weight) is 8970 psi. This value will conservatively used in the fatigue crack growth calculation. The thermal transient stress is reported in [2] as 7864.6 psi. The sum of these two values (=8970+7864.6= 16834.6 psi) will be used as the maximum of the stress cycle for fatigue crack growth calculation.

Weld residual stresses are steady state secondary stresses. Since a K-independent crack growth correlation is used in the IGSCC crack growth calculation as described below, residual stresses do not affect the IGSCC growth calculation in this evaluation. Because they are steady state stresses, residual stresses only affect fatigue crack growth as a mean stress. Therefore, in lieu of using a residual stress

distribution, a constant stress of 30 ksi (comparable to material yield stress) will conservatively be used as a mean stress in the fatigue crack growth calculation.

Seismic stresses, either OBE or SSE are not generally included in fatigue crack growth calculations, because the number of expected cycles is so small over the life of the plant. Also, there is an extremely low probability of an operating basis earthquake (OBE) seismic event occurring in the two year evaluation period, and the number of fatigue cycles per event is small. Therefore, the use of the primary stress values from [2] as described above is appropriate.

4.0 ASSUMPTIONS

Basic assumptions for the analysis are listed below:

1. Weld PD1A-D14 in the Dresden recirculation system does not experience a large number of cycles. Most stress cycles in this system are due to plant start-up/shutdown cycles

2. Residual stress is modeled as a constant tensile stress of 30 ksi (comparable to material yield stress) for the purpose of fatigue crack growth. Residual stresses are steady state secondary stresses and therefore only act as a mean stress in regards to fatigue crack growth.

3. The flaw indication is assumed to extend 360 degrees circumferentially around the pipe in LEFM crack growth calculations.

5.0 CRACK GROWTH CALCULATIONS

5.1 Fatigue Crack Growth (FCG)

FCG is calculated using the loading described in Section 3.2 of this calculation. In order to eliminate flaw length changes from consideration, the initial flaw was conservatively assumed to extend 360 degrees around the circumference. The minimum stress is taken as a constant value of 30 ksi, representing weld residual stress, which is present when the plant is shutdown. The maximum stress intensity K_{max} is the combination of the pressure, thermal, and deadweight stresses and the (constant) residual stress. K_{min} corresponds to residual stress only. This stress intensity range represents the range seen from shutdown to startup. The FCG after 1000 applied cycles is calculated using **pc-CRACK** software using the crack growth law for austenitic material in air, as described by Figure C-3210-1 in Section XI Appendix C of the ASME Code [3]. 1000 cycles was chosen as a conservative estimate that more than doubles the total number of startup and shutdown cycles the plant will likely experience over its lifetime Appendix A contains output files for the fatigue crack growth calculation. Over 1000 cycles including primary and thermal stresses as described above, the flaw is predicted to grow from 0.32 inch deep to 0.3259 inch deep, or a growth of 0.0059 inch.

5.2 Intergranular Stress Corrosion Cracking (IGSCC)

PVP2007-26618 [6] provides stress corrosion crack growth laws for austenitic stainless steel materials in the BWR environment, considering both normal water chemistry and hydrogen water chemistry. This paper provides the technical basis of crack growth correlations used in BWRVIP-14A. Appendix C of this calculation presents a historical summary of hydrogen water chemistry present in the Dresden Unit Reactor Recirculation System. Based on the data in Appendix C, weld PD1A-D14 is mitigated by effective hydrogen water chemistry. On that basis, the SCC crack growth law for hydrogen water chemistry provided by Reference [6] equation 6 is justified.

The SCC growth law is, taken from Reference [6], equation 6:

$$da/dt = 1.1 \times 10^{-5} \text{ in/hr} \qquad (1)$$

Note that this correlation is K-independent (stress independent as well). Using this correlation, the observed indication, which is reported as 0.32 inch deep, would grow by 0.193 inch in two years (17520 hours). The flaw depth would increase from 0.32 inch to 0.513 inch, which is 37% of the wall thickness reported in the inspection report, as compared to the allowable depth of 75% for the actual reported flaw length of 1 inch, or about 60% assuming the flaw extends 360 degrees circumferentially. Extending the IGSCC crack growth prediction, the reported flaw would be predicted require about 5.2 years to grow to the 60% depth. Using the same IGSCC growth correlation along with the FCG results above, a flaw depth of about 0.6 inch would just grow to the 360 degree allowable depth (60%) over the next two year inspection interval. The current indication could have been approximately double the current size and still not grow beyond the IWB-3641 allowable depth over the next operating cycle.

6.0 RESULTS AND CONCLUSIONS

The present analysis shows that over the next operating cycle, the observed indication would conservatively be expected to grow from the current 0.32 inch depth to a maximum depth of 0.52 inch due to the combination of IGSCC and fatigue crack growth. This end of evaluation period depth represents 38% of the wall thickness, as compared to and allowable depth per IWB-3641 of about 60% for a 360 degree flaw, or 75% for the as-measured flaw length. Thus, the final flaw size remains acceptable by the criteria of ASME Section XI IWB 3640 through well beyond (5.2 years) the end of the next two year inspection interval. This prediction is quite conservative, because of the very conservative treatment of residual stress, flaw shape and length modeled, applied stresses considered, and crack growth correlation used [5].

7.0 REFERENCES

1. Exelon Analysis DRE-98-0017, Reactor Recirculation Piping Stress Analysis, Revision 001A, May, 2004
2. Commonwealth Edison Calculation NED-P-MSD-085, Flaw Evaluation for PD1A-D14 and PS2-TEE/202-4B Welds in Dresden Unit 2 Recirculation System, Revision 0, 10/1995.
3. ASME Boiler & Pressure Vessel Code, Section XI, 1995 Edition, with 1996 Addenda
4. **pc-CRACK** for Windows, Version 3.1-98348, Structural Integrity Associates, 1998.
5. GE-Hitachi Inspection Report D2R21-027 Dated 11/10/09. Included as Appendix B to this calculation.
6. ASME Paper PVP2007-26618, Technical Basis for BWRVIP Stainless Steel Crack Growth Correlations in BWRs, 2007
7. Dresden Transmittal of Design Input (TODI) 09-045, "Hydrogen Water Chemistry Data", dated November 14, 2009. Included as Appendix C to this calculation.

APPENDIX A

FATIGUE CRACK GROWTH PC-CRACK OUTPUT FILES

pc-CRACK for Windows
Version 3.1-98348
(C) Copyright '84 - '98
Structural Integrity Associates, Inc.

Linear Elastic Fracture Mechanics

Date: Sun Nov 15 12:03:51 2009
Input Data and Results File: FCGD14.LFM

Title: 0901309.302 Fatigue crack growth for weld PD1A-D14

Load Cases:

	Stress Coefficients				
Case ID	C0	C1	C2	C3	Type
Unit	10	0	0	0	Coeff

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

Wall Depth	Case Unit
0.0000	10
0.0800	10
0.1600	10
0.2400	10
0.3200	10
0.4000	10
0.4800	10
0.5600	10
0.6400	10
0.7200	10
0.8000	10

Crack Model: Circumferential Crack in Cylinder (t/R=0.1)

Crack Parameters:
Wall thickness: 1.3700
Max. crack size: 0.8000

Crack Size	Stress Intensity Factor---------- Case Unit
0.0160	2.48378
0.0320	3.52415
0.0480	4.33034
0.0640	5.01658
0.0800	5.62697
0.0960	6.18405
0.1120	6.70115
0.1280	7.18694
0.1440	7.66532
0.1600	8.14893
0.1760	8.619
0.1920	9.07781
0.2080	9.52713
0.2240	9.96838
0.2400	10.4027
0.2560	10.8311
0.2720	11.2544
0.2880	11.7138
0.3040	12.1774
0.3200	12.6401
0.3360	13.1023
0.3520	13.5641
0.3680	14.0259
0.3840	14.4879
0.4000	14.9503
0.4160	15.4438
0.4320	16.0074
0.4480	16.5754
0.4640	17.148
0.4800	17.7251
0.4960	18.3068
0.5120	18.893
0.5280	19.4837
0.5440	20.079
0.5600	20.7029
0.5760	21.3402
0.5920	21.9829
0.6080	22.631

0.6240	23.2844
0.6400	23.9432
0.6560	24.6073
0.6720	25.2767
0.6880	25.9615
0.7040	26.6958
0.7200	27.4366
0.7360	28.1837
0.7520	28.9372
0.7680	29.6969
0.7840	30.4629
0.8000	31.235

Crack Growth Laws:

Law ID: XI-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 = 1.1017e-010
is for the currently selected units of:
force: kip
length: inch
temperature: 70.0000 Fahrenheit

Material Fracture Toughness KIc:

Material ID: K 200

Depth	KIc
0.0000	200.0000
0.5000	200.0000

2.0000 200.0000

Initial crack size= 0.3200
Max. crack size= 0.8000

Number of blocks= 1
Print increment of block= 1

Subblock	Cycles /Time	Calc. incre.	Print incre.	Crk. Grw. Law	Mat. K1c
operating	1000	10	10	XI-Air	K 200

Subblock	Kmax Case ID	Kmax Scale Factor	Kmin Case ID	Kmin Scale Factor
operating	Unit	3.0000	Unit	3.0000
	Unit	1.6850		

Crack growth results:

Total Cycles /Time	Subblock Cycles /Time	Kmax	Kmin	DeltaK	R	DaDn /DaDt	Da	a	a/thk
Block: 1									
10	10	5.92e+001	3.79e+001	2.13e+001	0.64	5.74e-006	5.74e-005	0.3201	0.23
20	20	5.92e+001	3.79e+001	2.13e+001	0.64	5.74e-006	5.74e-005	0.3201	0.23
30	30	5.92e+001	3.79e+001	2.13e+001	0.64	5.74e-006	5.74e-005	0.3202	0.23
40	40	5.92e+001	3.79e+001	2.13e+001	0.64	5.74e-006	5.74e-005	0.3202	0.23
50	50	5.93e+001	3.79e+001	2.13e+001	0.64	5.75e-006	5.75e-005	0.3203	0.23
60	60	5.93e+001	3.79e+001	2.13e+001	0.64	5.75e-006	5.75e-005	0.3203	0.23
70	70	5.93e+001	3.80e+001	2.13e+001	0.64	5.75e-006	5.75e-005	0.3204	0.23
80	80	5.93e+001	3.80e+001	2.13e+001	0.64	5.75e-006	5.75e-005	0.3205	0.23
90	90	5.93e+001	3.80e+001	2.13e+001	0.64	5.76e-006	5.76e-005	0.3205	0.23
100	100	5.93e+001	3.80e+001	2.13e+001	0.64	5.76e-006	5.76e-005	0.3206	0.23
110	110	5.93e+001	3.80e+001	2.13e+001	0.64	5.76e-006	5.76e-005	0.3206	0.23
120	120	5.93e+001	3.80e+001	2.13e+001	0.64	5.76e-006	5.76e-005	0.3207	0.23
130	130	5.93e+001	3.80e+001	2.13e+001	0.64	5.77e-006	5.77e-005	0.3207	0.23
140	140	5.93e+001	3.80e+001	2.13e+001	0.64	5.77e-006	5.77e-005	0.3208	0.23
150	150	5.93e+001	3.80e+001	2.13e+001	0.64	5.77e-006	5.77e-005	0.3209	0.23

160	160	5.93e+001	3.80e+001	2.13e+001	0.64	5.77e-006	5.77e-005	0.3209 0.23
170	170	5.93e+001	3.80e+001	2.13e+001	0.64	5.78e-006	5.78e-005	0.321 0.23
180	180	5.94e+001	3.80e+001	2.13e+001	0.64	5.78e-006	5.78e-005	0.321 0.23
190	190	5.94e+001	3.80e+001	2.13e+001	0.64	5.78e-006	5.78e-005	0.3211 0.23
200	200	5.94e+001	3.80e+001	2.14e+001	0.64	5.78e-006	5.78e-005	0.3212 0.23
210	210	5.94e+001	3.80e+001	2.14e+001	0.64	5.79e-006	5.79e-005	0.3212 0.23
220	220	5.94e+001	3.80e+001	2.14e+001	0.64	5.79e-006	5.79e-005	0.3213 0.23
230	230	5.94e+001	3.80e+001	2.14e+001	0.64	5.79e-006	5.79e-005	0.3213 0.23
240	240	5.94e+001	3.80e+001	2.14e+001	0.64	5.79e-006	5.79e-005	0.3214 0.23
250	250	5.94e+001	3.80e+001	2.14e+001	0.64	5.80e-006	5.80e-005	0.3214 0.23
260	260	5.94e+001	3.80e+001	2.14e+001	0.64	5.80e-006	5.80e-005	0.3215 0.23
270	270	5.94e+001	3.81e+001	2.14e+001	0.64	5.80e-006	5.80e-005	0.3216 0.23
280	280	5.94e+001	3.81e+001	2.14e+001	0.64	5.80e-006	5.80e-005	0.3216 0.23
290	290	5.94e+001	3.81e+001	2.14e+001	0.64	5.81e-006	5.81e-005	0.3217 0.23
300	300	5.94e+001	3.81e+001	2.14e+001	0.64	5.81e-006	5.81e-005	0.3217 0.23
310	310	5.95e+001	3.81e+001	2.14e+001	0.64	5.81e-006	5.81e-005	0.3218 0.23
320	320	5.95e+001	3.81e+001	2.14e+001	0.64	5.81e-006	5.81e-005	0.3218 0.23
330	330	5.95e+001	3.81e+001	2.14e+001	0.64	5.82e-006	5.82e-005	0.3219 0.23
340	340	5.95e+001	3.81e+001	2.14e+001	0.64	5.82e-006	5.82e-005	0.322 0.24
350	350	5.95e+001	3.81e+001	2.14e+001	0.64	5.82e-006	5.82e-005	0.322 0.24
360	360	5.95e+001	3.81e+001	2.14e+001	0.64	5.82e-006	5.82e-005	0.3221 0.24
370	370	5.95e+001	3.81e+001	2.14e+001	0.64	5.83e-006	5.83e-005	0.3221 0.24
380	380	5.95e+001	3.81e+001	2.14e+001	0.64	5.83e-006	5.83e-005	0.3222 0.24
390	390	5.95e+001	3.81e+001	2.14e+001	0.64	5.83e-006	5.83e-005	0.3223 0.24
400	400	5.95e+001	3.81e+001	2.14e+001	0.64	5.83e-006	5.83e-005	0.3223 0.24
410	410	5.95e+001	3.81e+001	2.14e+001	0.64	5.84e-006	5.84e-005	0.3224 0.24
420	420	5.95e+001	3.81e+001	2.14e+001	0.64	5.84e-006	5.84e-005	0.3224 0.24
430	430	5.95e+001	3.81e+001	2.14e+001	0.64	5.84e-006	5.84e-005	0.3225 0.24
440	440	5.96e+001	3.81e+001	2.14e+001	0.64	5.84e-006	5.84e-005	0.3225 0.24
450	450	5.96e+001	3.81e+001	2.14e+001	0.64	5.85e-006	5.85e-005	0.3226 0.24
460	460	5.96e+001	3.81e+001	2.14e+001	0.64	5.85e-006	5.85e-005	0.3227 0.24
470	470	5.96e+001	3.82e+001	2.14e+001	0.64	5.85e-006	5.85e-005	0.3227 0.24
480	480	5.96e+001	3.82e+001	2.14e+001	0.64	5.85e-006	5.85e-005	0.3228 0.24
490	490	5.96e+001	3.82e+001	2.14e+001	0.64	5.86e-006	5.86e-005	0.3228 0.24
500	500	5.96e+001	3.82e+001	2.14e+001	0.64	5.86e-006	5.86e-005	0.3229 0.24
510	510	5.96e+001	3.82e+001	2.14e+001	0.64	5.86e-006	5.86e-005	0.323 0.24
520	520	5.96e+001	3.82e+001	2.14e+001	0.64	5.86e-006	5.86e-005	0.323 0.24
530	530	5.96e+001	3.82e+001	2.14e+001	0.64	5.87e-006	5.87e-005	0.3231 0.24
540	540	5.96e+001	3.82e+001	2.14e+001	0.64	5.87e-006	5.87e-005	0.3231 0.24
550	550	5.96e+001	3.82e+001	2.15e+001	0.64	5.87e-006	5.87e-005	0.3232 0.24
560	560	5.97e+001	3.82e+001	2.15e+001	0.64	5.88e-006	5.88e-005	0.3233 0.24
570	570	5.97e+001	3.82e+001	2.15e+001	0.64	5.88e-006	5.88e-005	0.3233 0.24
580	580	5.97e+001	3.82e+001	2.15e+001	0.64	5.88e-006	5.88e-005	0.3234 0.24
590	590	5.97e+001	3.82e+001	2.15e+001	0.64	5.88e-006	5.88e-005	0.3234 0.24
600	600	5.97e+001	3.82e+001	2.15e+001	0.64	5.89e-006	5.89e-005	0.3235 0.24

610	610	5.97e+001	3.82e+001	2.15e+001	0.64	5.89e-006	5.89e-005	0.3235 0.24
620	620	5.97e+001	3.82e+001	2.15e+001	0.64	5.89e-006	5.89e-005	0.3236 0.24
630	630	5.97e+001	3.82e+001	2.15e+001	0.64	5.89e-006	5.89e-005	0.3237 0.24
640	640	5.97e+001	3.82e+001	2.15e+001	0.64	5.90e-006	5.90e-005	0.3237 0.24
650	650	5.97e+001	3.82e+001	2.15e+001	0.64	5.90e-006	5.90e-005	0.3238 0.24
660	660	5.97e+001	3.82e+001	2.15e+001	0.64	5.90e-006	5.90e-005	0.3238 0.24
670	670	5.97e+001	3.83e+001	2.15e+001	0.64	5.90e-006	5.90e-005	0.3239 0.24
680	680	5.97e+001	3.83e+001	2.15e+001	0.64	5.91e-006	5.91e-005	0.324 0.24
690	690	5.98e+001	3.83e+001	2.15e+001	0.64	5.91e-006	5.91e-005	0.324 0.24
700	700	5.98e+001	3.83e+001	2.15e+001	0.64	5.91e-006	5.91e-005	0.3241 0.24
710	710	5.98e+001	3.83e+001	2.15e+001	0.64	5.91e-006	5.91e-005	0.3241 0.24
720	720	5.98e+001	3.83e+001	2.15e+001	0.64	5.92e-006	5.92e-005	0.3242 0.24
730	730	5.98e+001	3.83e+001	2.15e+001	0.64	5.92e-006	5.92e-005	0.3243 0.24
740	740	5.98e+001	3.83e+001	2.15e+001	0.64	5.92e-006	5.92e-005	0.3243 0.24
750	750	5.98e+001	3.83e+001	2.15e+001	0.64	5.92e-006	5.92e-005	0.3244 0.24
760	760	5.98e+001	3.83e+001	2.15e+001	0.64	5.93e-006	5.93e-005	0.3244 0.24
770	770	5.98e+001	3.83e+001	2.15e+001	0.64	5.93e-006	5.93e-005	0.3245 0.24
780	780	5.98e+001	3.83e+001	2.15e+001	0.64	5.93e-006	5.93e-005	0.3245 0.24
790	790	5.98e+001	3.83e+001	2.15e+001	0.64	5.93e-006	5.93e-005	0.3246 0.24
800	800	5.98e+001	3.83e+001	2.15e+001	0.64	5.94e-006	5.94e-005	0.3247 0.24
810	810	5.99e+001	3.83e+001	2.15e+001	0.64	5.94e-006	5.94e-005	0.3247 0.24
820	820	5.99e+001	3.83e+001	2.15e+001	0.64	5.94e-006	5.94e-005	0.3248 0.24
830	830	5.99e+001	3.83e+001	2.15e+001	0.64	5.95e-006	5.95e-005	0.3248 0.24
840	840	5.99e+001	3.83e+001	2.15e+001	0.64	5.95e-006	5.95e-005	0.3249 0.24
850	850	5.99e+001	3.83e+001	2.15e+001	0.64	5.95e-006	5.95e-005	0.325 0.24
860	860	5.99e+001	3.84e+001	2.15e+001	0.64	5.95e-006	5.95e-005	0.325 0.24
870	870	5.99e+001	3.84e+001	2.15e+001	0.64	5.96e-006	5.96e-005	0.3251 0.24
880	880	5.99e+001	3.84e+001	2.15e+001	0.64	5.96e-006	5.96e-005	0.3251 0.24
890	890	5.99e+001	3.84e+001	2.15e+001	0.64	5.96e-006	5.96e-005	0.3252 0.24
900	900	5.99e+001	3.84e+001	2.16e+001	0.64	5.96e-006	5.96e-005	0.3253 0.24
910	910	5.99e+001	3.84e+001	2.16e+001	0.64	5.97e-006	5.97e-005	0.3253 0.24
920	920	5.99e+001	3.84e+001	2.16e+001	0.64	5.97e-006	5.97e-005	0.3254 0.24
930	930	5.99e+001	3.84e+001	2.16e+001	0.64	5.97e-006	5.97e-005	0.3254 0.24
940	940	6.00e+001	3.84e+001	2.16e+001	0.64	5.97e-006	5.97e-005	0.3255 0.24
950	950	6.00e+001	3.84e+001	2.16e+001	0.64	5.98e-006	5.98e-005	0.3256 0.24
960	960	6.00e+001	3.84e+001	2.16e+001	0.64	5.98e-006	5.98e-005	0.3256 0.24
970	970	6.00e+001	3.84e+001	2.16e+001	0.64	5.98e-006	5.98e-005	0.3257 0.24
980	980	6.00e+001	3.84e+001	2.16e+001	0.64	5.99e-006	5.99e-005	0.3257 0.24
990	990	6.00e+001	3.84e+001	2.16e+001	0.64	5.99e-006	5.99e-005	0.3258 0.24
1000	1000	6.00e+001	3.84e+001	2.16e+001	0.64	5.99e-006	5.99e-005	0.3259 0.24

End of pc-CRACK Output

APPENDIX B
GE-Hitachi Inspection Report D2R21-027 Dated 11/10/09

HITACHI	EXAMINATION SUMMARY SHEET	Report No.: D2R21-027

Site: **Dresden** Component ID: **2/1/0201A-28/PD1A-D14**

Outage: **RFO 21** **EL-P / 28"**

System: **RR** ASME Cat.: **N/A** ASME Item **N/A** Aug Req **IGSCC / Cat. F**

Exams Performed	Data Sheet	Cal Sheet	Procedure	Calibration Block	Exam / Oper. Personnel	Cert Level	Date
60° Shear	D-022	N/A	GE-PDI-UT-3 Ver/Rev 2	CAL-DPTH-068	Chad Olson	II	11/6/2009
45° Shear	D-023	N/A	GE-PDI-UT-2 Ver/Rev 4*	DRE-PDI-304-01	Troy Huhe	II	11/6/2009
60° Long.	D-024	N/A	GE-PDI-UT-2 Ver/Rev 4*	DRE-PDI-304-01	Troy Huhe	II	11/6/2009

Examination Results:

Ultrasonic examinations were performed using both detection and sizing techniques with a combination of 45° shear and a 60° longitudinal wave search units.

Detection techniques using the 45° shear and 60° RL search units detected the previously recorded linear indication with no significant change noted. No new indication were detected. See D2R14 data for indication plots.

Sizing exams were performed on the previously recorded linear indication with the following parameters:

Ind. No.	L start	Length	Thru-wall	Location
1	32.0"	1.0"	.32"	Pipe Side

No significant change was observed from the previously recorded dimensions for this indication.

87.75% of the required examination volume was examined.

This examination meets the requirements of ASME Section XI 1995 Edition, 1996 Addenda.

*DRR 07-04/07-29

Examination results were compared to Data Report D-020, 021, 022 *from:* D2R20 ☐ *Change*

These examinations were performed under Work Order: 01096691-06 ☑ *No Change*

This Summary and the following data sheets have been reviewed and accepted by the following personnel

Scott R Erickson III 11/7/09 11.8.09
Prepared By: Level: Date: Utility Review: Date:

Scott R Erickson III 11/7/09 11.10.09
GE Review By: Level: Date: ANII Review: Date:

RWP: 1001-0426
Dose: 177 mr.

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HITACHI

Ultrasonic Calibration and Examination Record
Manual Piping and Components

Site/Unit: Dresden / 2
Outage: RFO 21

Report Number: D2R21-027
Data Sheet Number: D-023
Linearity Sheet: L-003

Calibration Data for Block: DRE-PDI-304-01

Procedure: GE-PDI-UT-2
Ver / Rev: 4 DRR: 07-04/07-29

SS	Flat	0.5"-2.0"	Calibration	Cal Time
Material	Size	Thick	Initial Cal:	1015
Ultragel II	07225		Cal Check:	1428
Couplant:	Couplant batch		Cal Check:	N/A
264882	76° F		Final Cal:	1552
Thermometer S/N	Cal Temp.			

DAC Construction

Scan Direction: Ax
Cal Reflector: 1.5" Notch
Signal Amplitude: 80%
Signal Sweep: 5.3 Div
Signal dB: 6.2 dB
Sweep 0-10 = 4.000 in Metal Path

Calibration Verification

Field Simulator Block S/N: CAL-RHOM-092

Reflector	FSDH	N/A
Amplitude	20%	N/A
Gain (dB)	6.2	N/A
Sweep (SD)	2.5	N/A

Acceptable Linearity performed: 10/28/2009

Search Unit Data

Manufacturer:	Serial Number	Size/Shape:
KBA	01H2MD	.375"/Round
Incident Point:	**Nominal Angle:**	**Measured Angle:**
0.3 in.	45°	45°

Frequency:	Style:	Mode:	Elements:
1.5 MHz	Comp-G	Shear	1

Search Unit Cable

Cable Type:	Length:	Connectors:
RG-174	6'	0

Instrument Settings

Manufacturer/Model:	Serial Number:
Panametrics / Epoch 4	031526704

Zero:	Velocity:	Narrowband Filter:
6.395 µs	0.1246 in./µsec.	0.8 - 3.0 MHz

Rep Rate:	Rectification:	Range:	Pulser/Energy:
Auto	Fullwave	4.000 in	Sq. / Max

Damping:	Reject:	Frequency:	Mode:
400 Ohms	0%	2.0 MHz	P/E

Exam Data for Weld: 2/1/0201A-28/PD1A-D14

Configuration: EL-P / 28"

Exam Surface:	Exam Temp.	Exam Thermometer
OD	89° F	264882

Axial Circ	UPST DNST	Scan dB	Recordable Indications	Exam Angle
Axial	UPST	18.2	NRI	45°
Axial	DNST	18.2	RI	45°
Circ	UPST	24.2	NRI	45°
Circ	DNST	24.2	NRI	45°

Exam Comments / Limitations:

See sizing data sheet for recorded indication.
Exam performed to maintain 5% to 20% ID roll.
Circ exams performed on both sides of base material and weld crown.
ID geometry observed below recordable levels.
No upstream axial scan performed between 26.0° to 70.0° due to welded restraint.
No new indications were detected.

Exam Start: 1430 Exam End: 1508

TH Troy Huhe II
Initials: Examiner: Level:

Michael Jenniges II
Initials: Examiner 2: Level:

Initial Cal/Exam Date: 11/6/2009

Scott R Erickson III 11/7/09
GE Reviewed By: Level: Date:

See Summary Sheet for Signature
Utility Review: Date:

See Summary Sheet for Signature
ANII Review: Date:

HITACHI

Ultrasonic Calibration and Examination Record
Manual Piping and Components

Site/Unit: Dresden / 2
Outage: RFO 21

Report Number: D2R21-027
Data Sheet Number: D-024
Linearity Sheet: L-003

Calibration Data for Block: DRE-PDI-304-01

SS	Flat	0.5"-2.0"	Calibration	Cal Time
Material	Size	Thick	Initial Cal:	1020
Ultragel II	07225		Cal Check:	1504
Couplant:	Couplant batch		Cal Check:	N/A
264882	76° F		Final Cal:	1554
Thermometer S/N	Cal Temp.			

Procedure: GE-PDI-UT-2
Ver / Rev: 4 DRR: 07-04/07-29

DAC Construction

Scan Direction: Ax
Cal Reflector: 1.5" Notch
Signal Amplitude: 80%
Signal Sweep: 5.8 Div
Signal dB: 35.2 dB
Sweep 0-10 = 5.000 in Metal Path

Search Unit Data

RTD	01-1290	2(1.5x25) mm/Rect.
Manufacturer:	Serial Number	Size/Shape:
0.65 In.	60°	60°
Incident Point:	Nominal Angle:	Measured Angle:

2.0 MHz	TRL2-Aust	Long.	2
Frequency:	Style:	Mode:	Elements:

Search Unit Cable

RG-174	6'	0
Cable Type:	Length:	Connectors:

Calibration Verification

Field Simulator Block S/N: CAL-RHOM-092

Reflector	NSDH	N/A
Amplitude	36%	N/A
Gain (dB)	35.2	N/A
Sweep (SD)	1.3	N/A

Acceptable Linearity performed : 10/28/2009

Instrument Settings

Panametrics / Epoch 4			031526704
Manufacturer/Model:			Serial Number:
12.31 µs	0.2373 in./µsec.		0.8 - 3.0 MHz
Zero:	Velocity:		Narrowband Filter:
Auto	Fullwave	5.000 in	Sq. / Max
Rep Rate:	Rectification:	Range:	Pulser/Energy:
400 Ohms	0%	2.0 MHz	Dual
Damping:	Reject:	Frequency:	Mode:

Exam Data for Weld: 2/1/0201A-28/PD1A-D14

EL-P / 28"
Configuration:

OD	89° F	264882
Exam Surface:	Exam Temp.	Exam Thermometer

Exam Comments / Limitations:

See sizing data sheet for recorded indication.
Exam performed to maintain 5% to 20% noise level.

Supplemental 60° RL examination performed due to welded restraint from 26.0" to 70.0" on downstream side of weld.

No new indications were detected.

Axial Circ	UPST DNST	Scan dB	Recordable Indications	Exam Angle
Axial	DNST	41.2	RI	60°

Exam Start: 1505 Exam End: 1525

TH Troy Huhe II
Initials: Examiner: Level:

Michael Jenniges II
Initials: Examiner 2: Level:

Initial Cal/Exam Date: 11/6/2009

Scott R Erickson III 11/7/09
GE Reviewed By: Level: Date:

See Summary Sheet for Signature
Utility Review: Date:

See Summary Sheet for Signature
ANII Review: Date:

HITACHI

Ultrasonic Calibration and Examination Record
Manual Piping and Components

Site/Unit: Dresden / 2
Outage: RFO 21

Report Number: D2R21-027
Data Sheet Number: D-022
Linearity Sheet: L-002

Calibration Data for Block: CAL-DPTH-068

SS	Flat	2.0"	Calibration	Cal Time
Material	Size	Thick	Initial Cal:	1040
Ultragel II	07225		Cal Check:	1309
Couplant:	Couplant batch		Cal Check:	N/A
264795	78° F		Final Cal:	1438
Thermometer S/N	Cal Temp.			

DAC Construction

Scan Direction: Ax
Cal Reflector: 1.2" SDH
Signal Amplitude: 80%
Signal Sweep: 5.80 Div
Signal dB: 33.8 dB
Sweep 0-10 = 4.000 in Metal Path

Calibration Verification

Field Simulator Block S/N: CAL-RHOM-093

Reflector	FSDH	N/A
Amplitude	80%	N/A
Gain (dB)	27.0	N/A
Sweep (SD)	3.7	N/A

Acceptable Linearity performed: 10/28/2009

Exam Data for Weld: 2/1/0201A-28/PD1A-D14

EL-P / 28"
Configuration:

OD — Exam Surface: | 92° F — Exam Temp. | 264795 — Exam Thermometer

Axial Circ	UPST DNST	Scan dB	Recordable Indications	Exam Angle
Axial	DNST	35.8	RI	60°

Procedure: GE-PDI-UT-3
Ver / Rev: 2 DRR: N/A

Search Unit Data

KBA	01DXNH	.375"/Round
Manufacturer:	Serial Number	Size/Shape:
0.25 In.	60°	59°
Incident Point:	Nominal Angle:	Measured Angle:

2.25 MHz	Comp-G	Shear	1
Frequency:	Style:	Mode:	Elements:

Search Unit Cable

RG-174	6'	0
Cable Type:	Length:	Connectors:

Instrument Settings

Panametrics / Epoch 4 — Manufacturer/Model: | 031533905 — Serial Number:

6.505 µs	0.1246 in./µsec.	0.8 - 3.0 MHz	
Zero:	Velocity:	Narrowband Filter:	
Auto	Fullwave	4.000 in	Sq. / Max
Rep Rate:	Rectification:	Range:	Pulser/Energy:
400 Ohms	0%	2.0 MHz	P/E
Damping:	Reject:	Frequency:	Mode:

Exam Comments / Limitations:

Exam performed to through wall size previously recorded flaw.

No significant changes.

Exam Start: 1310 Exam End: 1330

CO — Initials: Chad Olson — Examiner: II — Level:

____ — Initials: N/A — Examiner 2: N/A — Level:

Initial Cal/Exam Date: 11/6/2009

Scott R Erickson III 11/12/09
GE Reviewed By: Level: Date:

See Summary Sheet for Signature — Utility Review: — Date:

See Summary Sheet for Signature — ANII Review: — Date:

HITACHI

Ultrasonic Examination Indication Report

Site: Dresden

Procedure: GE-PDI-UT-2 / 4 / 07-04/07-29

Data Report Number: D2R21-027

Cal / Data Sheet Number: D-024

Weld ID: 2/1/0201A-28/PD1A-D14 Drawing: 103-2 Size: 28.0" Thickness: 1.375" Exam Start: 1430

Lo Location: OSR of Elbow Wo Location: Weld Centerline Weld Width: 1.4" Weld Height: 0.1" Exam End: 1525

Ind No.	Angle Used	% of DAC	Indication Length			W Distance			Metal Path			Ax / Circ	Upst/ Dnst	Comments:
			L1	L Max	L 2	W1	W Max	W 2	MP 1	MP Max	MP 2			
1	60	N/A	N/A	32.5"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Circ	Dnst	Indication length, no change from previous data.

Sketch

TH Troy Huhe II 11/6/2009
Examiner Level: Date:

Scott R Erickson III 11/7/09
GE Reviewed By: Level: Date:

See Summary Sheet for Signature
Utility Review: Date:

See Summary Sheet for Signature
ANII Review: Date:

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HITACHI

Ultrasonic Examination Indication Report

Site: Dresden

Procedure: GE-PDI-UT-3/2/N/A

Data Report Number: D2R21-027

Cal / Data Sheet Number: D-022

Weld ID: 2/1/0201A-28/PD1A-D14 Drawing: 103-2 Size: 28" Thickness: 1.375" Exam Start: 1310

Lo Location: OSR of Elbow Wo Location: Weld Centerline Weld Width: 1.4" Weld Height: 1" Exam End: 1330

Ind No.	Angle Used	% of DAC	Indication Length			W Distance			Metal Path			Ax / Circ	Upst/ Dnst	Comments:
			L1	L Max	L 2	W1	W Max	W 2	MP 1	MP Max	MP 2			
1	60	N/A	N/A	32.5"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Circ	Dnst	Indication 0.32" through wall. No significant changes from previous outage.

Sketch

CO Chad Olson II 11/6/2009
Examiner Level: Date:

Scott R Erickson III 11/7/09
GE Reviewed By: Level: Date:

See Summary Sheet for Signature
Utility Review: Date:

See Summary Sheet for Signature
ANII Review: Date:

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HITACHI

Wall Thickness Profile Sheet

Site: Dresden Unit: 2

Project: RFO 21

Report No.: D2R21-027

System: RR

Component ID Number: 2/1/0201A-28/PD1A-D14

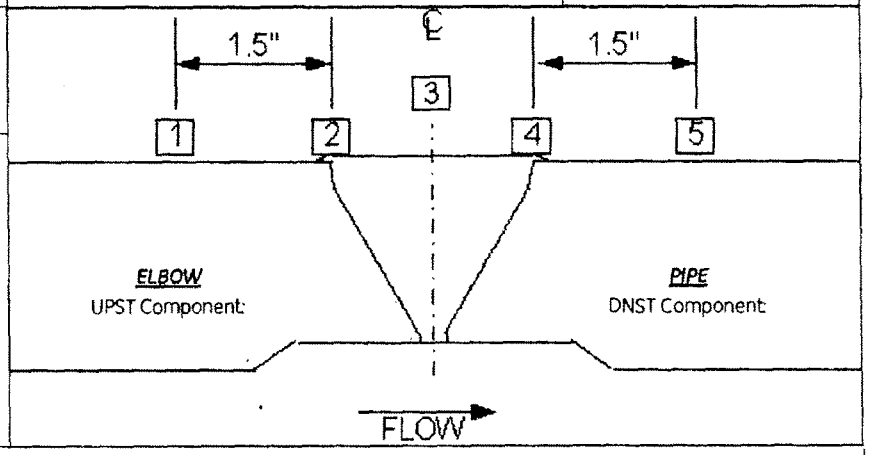
Position	0°	90°	180°	270°
1	1.40"	N/A	N/A	N/A
2	1.40"	N/A	N/A	N/A
3	1.49"	N/A	N/A	N/A
4	1.41"	N/A	N/A	N/A
5	1.43"	N/A	N/A	N/A

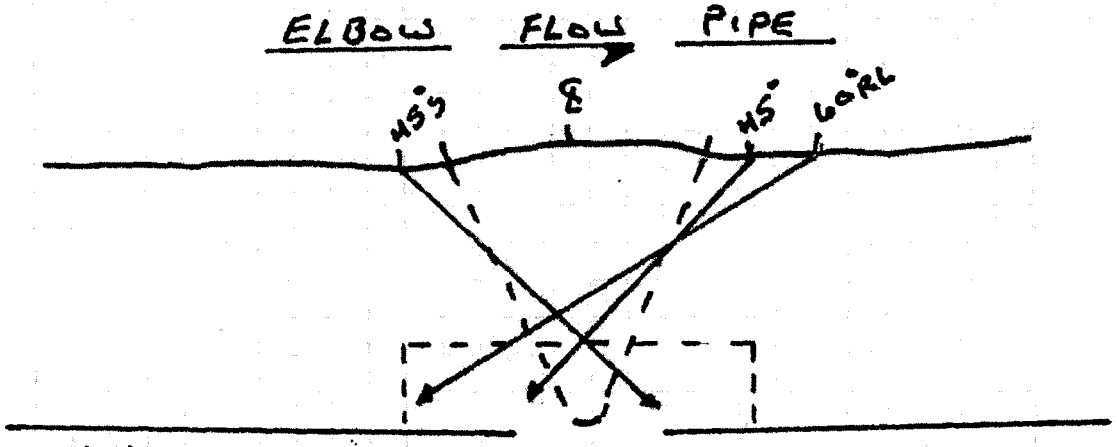
Crown Height: .05"

Crown Width: 1.4"

Nominal Diameter: 28.0"

Weld Length: 90.0"





* NOTE: SEE CAL. SHTS FOR EXAM PARAMETERS DUE TO WELDED RESTRAINT ON UPSTREAMSIDE.

TH	Troy Huhe	II	11/5/2009	Scott R Erickson III	11/7/09	See Summary Sheet for Signature	See Summary Sheet for Signature
	Drawn by:	Level:	Date:	GE Reviewed By:	Level: Date:	Utility Review: Date:	ANII Review: Date:

HITACHI	Indication / Coverage Plot Sheet	Site: Dresden Unit: 2 Project: RFO 21	Report Number: D2R21-027

System: RR Component ID Number: 2/1/0201A-28/PD1A-D14 Configuration: ELBOW to PIPE

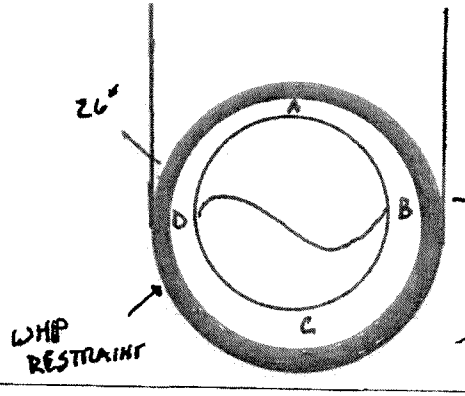
Coverage Calculations:

Upstream Scan (Elbow Side) limited by Whip Restraint located approximately 2.1" upstream of weld. Whip restraint is not centered around pipe, with distance from pipe to whip restraint ranging from 0.8" to 2.8". Due to this condition, the area from 26.0" cw to 70.0" cw could not be examined.

Axial Upstream Scan: 46.0" of 90.0" of circumference scanned = 51%
Axial Downstream Scan: 90.0" of 90.0" of circumference scanned = 100%
Clockwise Scan (U/S and D/S): 90.0" of 90.0" of circumference scanned = 100%
Counter-Clockwise Scan (U/S and D/S): 90.0" of 90.0" of circumference scanned = 100%

A = 0.8" C = 2.8"
B = 1.7" D = 1.7"

Axial Upstream Scan: 51% of 25% = 12.75%
Axial Downstream Scan: 100% of 25% = 25.00%
Clockwise Scan: 100% of 25% = 25.00%
Counter-Clockwise Scan: 100% of 25% = 25.00%
Total coverage achieved = 87.75%



SRE 11/9/09

11-8-09

11-9-09

Scott R Erickson
Scott Erickson III 11/6/2009
Drawn by: Level: Date:

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APPENDIX C

Dresden Transmittal of Design Input (TODI) 09-045, "Hydrogen Water Chemistry Data," dated November 14, 2009

Exelon

EXELON TRANSMITTAL OF DESIGN INFORMATION

☒SAFETY-RELATED ☐NON-SAFETY-RELATED ☐REGULATORY RELATED	Originating Organization ☒Exelon ☐Other (specify)	TODI No. 09-045
Station Unit(s) System Designation: Dresden Unit 2		Page 1 of 2
		To:

Subject Hydrogen Water Chemistry Data

PINDER MANKOO Preparer	Preparer's Signature	11-14-2009 Date
N/A Reviewer	N/A Reviewer's Signature	N/A Date
R Sorrner Approver	Approver's Signature	11/14/09 Date

Status of Information: ☑Approved for Use ☐Unverified

Method and Schedule of Verification for Unverified TODIs:

Description of Information:

Purpose of Issuance:

Source Documents:

Distribution:

EXELON TRANSMITTAL OF DESIGN INFORMATION	TODI NO. 09-045 Page 2 of 2 .

Dresden Unit 2 has been operating under Hydrogen Water Chemistry (HWC) since 1983. NobleChem™ was implemented during the fall outage in 1999, and reapplication of NobleChem™ was performed in the fall of 2003.

Hydrogen availability over the last two cycles has been between 98.3% and 99.5% at temperatures above 200°F. Barring major transients, it is expected that hydrogen availability will be above 98% with a goal of at least 90% during the coming cycle.

The other parameters over the last two cycles were as follows:

- Electrochemical Corrosion Potential (ECP) was between -491 and –476 mV (SHE), with an inspection relief goal of <-230mV
- Measured hydrogen to oxygen molar ratio was between 495 and 289, with an inspection relief goal of 4:1
- Reactor dissolved oxygen at 0.3 ppb, with an inspection relief goal of < 5 ppb
- Average Reactor conductivity between 0.074 and 0.095 µS/cm, with an inspection relief goal of < 0.3 µS/cm
- Trend of Pt/Rh loading is projected to have sufficient noble chemicals for cycle 22, meeting the inspection relief goal of >0.15 µg/cm^2. On-Line Noble Chem (OLNC) is planned for application to Dresden Unit-2 in 2010 to maintain the Pt/Rh loading.

It is currently expected that Cycle 21 chemistry can be routinely achieved, barring major transients. Provided the reactor water chemistry can be maintained in Cycle 22 at comparable values to those in Cycle 21, the Hydrogen Water Chemistry & Noble Chemistry (HWC/NobleChem™) crack growth from BWRVIP-14 are valid and can be utilized.