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RS-09-165

December 7, 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 Updated 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) is submitting an updated 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. Two flaw indications located at the weld do 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.

An NRC Region III inspector raised questions, during the recent DNPS Unit 2 refueling outage (i.e., D2R21), regarding this weld, which contains two previously known circumferential flaw indications. The inspector's questions centered on the fact that neither the original flaw evaluation (Reference 2) nor the NRC safety evaluation (Reference 3) discussed the examination limitations. During a subsequent telephone call, it was agreed to update our flaw evaluation to the current ASME Code edition and addenda and to clearly identify and justify the examination limitations.

The weld 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 indications are located in weld PS2-TEE/202-4B, which is a Category "F" weld, on the tee side of a 28-inch diameter "A" Recirculation Pump tee to valve weld. There are no axial flaw indications detected in this weld. The tee material is SA403 WP304 wrought material; the valve material is SA-358 CF8M cast stainless steel material. The length of the flaw indications are identified in the attachment to this letter and are unchanged from the previous examination which also used PDI qualified personnel, equipment, and procedures. In fact, the two indications have not changed since first identified in 1995 (see Reference 2) and, therefore, sample expansion is not necessary.

An evaluation of the circumferential flaw indications assuming a conservative estimate of crack growth using linear elastic fracture mechanics 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 and expected growth rates assuming hydrogen water chemistry and plant chemistry parameters. It demonstrates that substantial structural margin exists for more than one operating cycle (i.e., 24 months duration) considering hydrogen 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, there were no examination limitations on the tee side of the weld. However, given the valve configuration and cast material, the required examination volume on the valve side could not be examined. Delta ferrite measurements were taken on the valve body and the results demonstrate an average delta ferrite content of 14.6 FN. Given the high ferrite content, the valve body can be considered resistant to intergranular stress corrosion cracking in the boiling water reactor environment. Using a conservative treatment of residual stress, flaw shape and length and crack growth correlations, the evaluation concluded 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 percent.

Therefore, EGC has concluded that the flaw indications are acceptable as-is for continued operation through the next operating cycle. Weld PS2-TEE/202-4B classification will remain as Category "F" (i.e., cracked weld with inadequate or no repair) and will require inspection each subsequent refueling outage.

There is no proprietary information contained in either this letter or its attachment.

EGC requests NRC review and approval of the attached flaw evaluation report by February 25, 2010.

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

Respectfully,

Darin Benyak
Director – Licensing and Regulatory Affairs
Exelon Generation Company, LLC

Attachment: Structural Integrity Associates, Inc. Report, "Crack Growth Analysis for Weld PS2-TEE/202-4B," File No.: 0901309.303

# ATTACHMENT

## Structural Integrity Associates, Inc. Report,

## "Crack Growth Analysis for Weld PS2-TEE/202-4B"

## File No.: 0901309.303

| Structural Integrity Associates, Inc.<br>**CALCULATION PACKAGE** | **File No.: 0901309.303**<br>**Project No.: 0901309**<br>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 PS2-TEE/202-4B

| Document Revision | Affected Pages | Revision Description | Project Manager Approval Signature & Date | Preparer(s) & Checker(s) Signatures & Date |
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| 0 | 1 - 8<br>A-1 - A-7<br>B-1 - B-8<br>C-1 – C-2<br>D-1 – D-2 | Initial Issue | H. L. Gustin<br>11/30/09 | H. L. Gustin<br>Preparer<br>11/30/09<br>Daniel V. Sommerville<br>Independent Verifier<br>11/30/09 |
| | | | | |

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## 1.0 INTRODUCTION/OBJECTIVE

The purpose of this calculation is to update the evaluation of two flaw indications observed in Weld PS2-TEE/202-4B, 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 two indications requiring evaluation [5]. These indications were also identified during the previous inspections. 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 [1]. The evaluation that follows incorporates these changes to the input data. The evaluation applies linear elastic fracture mechanics (LEFM) to 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 applied stresses for Weld PS2-TEE/202-4B are 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 PS2-TEE/202-4B are described below. These are taken from the previous evaluation [2].

| | |
|---|---|
| Tee Material (from [2] page 8): | SA403 WP 304 Austenitic Stainless Steel |
| Valve Material (From Appendix D) | SA-358 CF8M Cast stainless steel |
| Allowable Stress Intensity Sm (typical): | 16.95 ksi |
| Yield Strength (typical): | 30 ksi |
| Outside diameter: | OD = 28 inches |
| Wall Thickness (from [2] page 18): | t = 1.2 inches |
| Configuration: | Tee-to-valve |

Yield and ultimate strength values are not used in the fatigue crack growth calculation below. The yield strength above is taken as a conservative upper bound on residual stress, as noted under assumption 2 below. A copy of the examination report is enclosed in Appendix B. The NDE inspection report [5] identifies two reportable indications, circumferentially oriented on the tee side of the weld. Reported dimensions are: Indication 1: length = 1.7 inches, depth = 0.36 inches; Indicaton 2: length = 2.8 inches, depth = 0.27 inches. The inspection report states that there is no change in this data from previous examinations. Per the inspection report [5], indication 1 is located from 16.2 to 17.9 inches azimuthally, and indication 2 is located from 68.6 to 71.4 inches azimuthally. The minimum separation is therefore about 32 inches. This corresponds to about 37% of circumference. These individual indications are sufficiently far apart to be evaluated separately.

| | |
|---|---|
| Combined Flaw Length to Pipe Circumference Ratio: | 0.05 |
| Table IWB 3641.1 Allowable Depth to Wall Thickness (a/t) Ratio: | 0.75 |
| Measured Flaw Depth to Wall Thickness (a/t) Ratio: | 0.3 |
| (Note: this is the ratio of flaw depth to nominal wall thickness of 1.2 inches) | |

Because of component geometry, the inspections were single-sided on the tee side of the weld. No limitation of inspection of the flaw locations was noted in the report on the tee side of the weld [5]. The cast stainless steel valve body on the valve side of the weld is highly resistant to IGSCC. There has been no known IGSCC in cast austenitic stainless steel components in the BWR. Measurements of delta ferrite content in this valve body were taken by Exelon, and the results (included in Appendix D of this calculation) demonstrate an average delta ferrite content of 14.6 FN. The NRC has supported the fact that cast austenitic stainless steels are resistant to IGSCC in the BWR and has noted that CF3 and CF8 valve and pump bodies, welded to resistant materials, are considered resistant to IGSCC (NUREG-0313 Revision 2). In addition, the NRC has supported a carbon ferrite concept by allowing low carbon cast components such as CF3 with sufficient ferrite (7.5 FN), to be considered resistant to IGSCC in the

BWR environment. As ferrite number increases, higher carbon material is considered resistant as well, as discussed in [9].

### 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) at any location is 8970 psi. This value will be conservatively used in the fatigue crack growth calculation. The thermal transient stress is reported in [2, page 20] as 7752 psi. The sum of these two values (=8970+7752= 16722 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 PS2-TEE/202-4B 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 indications are modeled as extending 360 degrees circumferentially around the pipe in the LEFM crack growth calculations.

4. Hydrogen water chemistry performance as summarized in Appendix C is assumed to be representative of the performance over the next operating cycle.

## 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, conservatively representing weld residual stress, which is present when the plant is shutdown. The maximum stress intensity $K_{max}$ is the sum 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]. (Note that ASME Section XI does not yet include fatigue crack growth laws for austenitic stainless steel in a BWR water environment.) A value of 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 the assumed 1000 cycles including primary and thermal stresses as described above, the flaw is predicted to grow from 0.36 inches deep to 0.3687 inches deep, or a growth of 0.0087 inches.

### 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 PS2-TEE/202-4B 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 larger of the observed indications, which is reported as 0.36 inches deep, would grow by 0.193 inches in two years (17520 hours). The flaw depth would increase from 0.36 inches to 0.553 inches, which is 46% of the nominal wall thickness as compared to the allowable depth of 75% for the actual reported

combined flaw length of 4.5 inches. The allowable depth to thickness ratio (for primary stress ratio of 0.6) from Table IWB 3641.1 for a flaw that extends 360° around the circumference of the pipe is 63% of wall thickness. Assuming that the combined flaw grows from its current length of 4.5 inches to 360° of pipe circumference (88 inches in length), the reported flaw is predicted to grow to 63% of wall thickness in 3.9 years. Using the IGSCC crack growth correlation along with the FCG results from above, and assuming that the flaw grows to 360°, a starting depth of 0.52 inches would be required for the flaw to grow to 63% of pipe wall thickness over the next two year inspection interval. On that basis, the current combined flaw could have been approximately 40% deeper than the currently reported depth and still not grow beyond the IWB 3641.1 allowable depth over the next operating cycle.

## 6.0 RESULTS AND CONCLUSIONS

The present analysis shows that over the next operating cycle, the deepest observed indication would conservatively be expected to grow from the current 0.36 inches depth to a maximum depth of 0.57 inches due to the combination of IGSCC and fatigue crack growth. This end of evaluation period depth represents 47.5% of the wall thickness, as compared to allowable depths per IWB-3641 of 75% for the as-measured flaw length and about 60% if the flaw were to grow to 360° in circumference. Thus, the final flaw size will remain acceptable by the criteria of ASME Section XI IWB-3640, well beyond 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 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 D2R21-029 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 30, 2009. Included as Appendix C to this calculation.
8. Dresden Transmittal of Design Input (TODI) 09-048, "Valve Body Material Properties for Valve 2-0202-4B," dated November 23, 2009. Included as Appendix D to this calculation.

9. EPRI Report NP-7103-D, "Justification for Extended Weld-Overlay Design Life", January 1991, prepared by Structural Integrity Associates.

# APPENDIX A

## FATIGUE CRACK GROWTH PC-CRACK OUTPUT FILES

tm
pc-CRACK for Windows
Version 3.1-98348
(C) Copyright '84 - '98
Structural Integrity Associates, Inc.
3315 Almaden Expressway, Suite 24
San Jose, CA 95118-1557
Voice: 408-978-8200
Fax: 408-978-8964
E-mail: pccrack@structint.com

Linear Elastic Fracture Mechanics

Date: Mon Nov 16 06:47:35 2009
Input Data and Results File: FCGTEE.LFM

Title: 0901309.303 Fatigue crack growth for weld PS2-Tee-2024B

Load Cases:

| Case ID | Stress Coefficients 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: 1.2000
Max. crack size: 0.8000

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

| Crack Size | Case Unit |
|---|---|
| 0.0160 | 2.48494 |
| 0.0320 | 3.52742 |
| 0.0480 | 4.33635 |
| 0.0640 | 5.02584 |
| 0.0800 | 5.63991 |
| 0.0960 | 6.20106 |
| 0.1120 | 6.72259 |
| 0.1280 | 7.23516 |
| 0.1440 | 7.74874 |
| 0.1600 | 8.24664 |
| 0.1760 | 8.73173 |
| 0.1920 | 9.20626 |
| 0.2080 | 9.67196 |
| 0.2240 | 10.1302 |
| 0.2400 | 10.5822 |
| 0.2560 | 11.0788 |
| 0.2720 | 11.5738 |
| 0.2880 | 12.0679 |
| 0.3040 | 12.5614 |
| 0.3200 | 13.0549 |
| 0.3360 | 13.5485 |
| 0.3520 | 14.0426 |
| 0.3680 | 14.5897 |
| 0.3840 | 15.1935 |
| 0.4000 | 15.8027 |
| 0.4160 | 16.4175 |
| 0.4320 | 17.0378 |
| 0.4480 | 17.6636 |
| 0.4640 | 18.295 |
| 0.4800 | 18.932 |
| 0.4960 | 19.6089 |
| 0.5120 | 20.2925 |
| 0.5280 | 20.9827 |
| 0.5440 | 21.6794 |

| | |
|---|---|
| 0.5600 | 22.3827 |
| 0.5760 | 23.0925 |
| 0.5920 | 23.8087 |
| 0.6080 | 24.5601 |
| 0.6240 | 25.3479 |
| 0.6400 | 26.1435 |
| 0.6560 | 26.9468 |
| 0.6720 | 27.7577 |
| 0.6880 | 28.5763 |
| 0.7040 | 29.4024 |
| 0.7200 | 30.236 |
| 0.7360 | 31.1404 |
| 0.7520 | 32.0535 |
| 0.7680 | 32.9753 |
| 0.7840 | 33.9057 |
| 0.8000 | 34.8445 |

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= 0.3600
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 | 1.6722 | | |

Crack growth results:

| | Cycles /Time | Total Cycles /Time | Subblock Kmax | Kmin | DeltaK | R | DaDn /DaDt | Da | a | a/thk |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Block: 1 | | | | | | | |
| 10 | 10 | 6.69e+001 | 4.29e+001 | 2.39e+001 | 0.64 | 8.45e-006 | 8.45e-005 | 0.3601 | 0.30 |
| 20 | 20 | 6.69e+001 | 4.30e+001 | 2.39e+001 | 0.64 | 8.45e-006 | 8.45e-005 | 0.3602 | 0.30 |
| 30 | 30 | 6.69e+001 | 4.30e+001 | 2.39e+001 | 0.64 | 8.46e-006 | 8.46e-005 | 0.3603 | 0.30 |
| 40 | 40 | 6.69e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.46e-006 | 8.46e-005 | 0.3603 | 0.30 |
| 50 | 50 | 6.69e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.47e-006 | 8.47e-005 | 0.3604 | 0.30 |
| 60 | 60 | 6.70e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.48e-006 | 8.48e-005 | 0.3605 | 0.30 |
| 70 | 70 | 6.70e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.48e-006 | 8.48e-005 | 0.3606 | 0.30 |
| 80 | 80 | 6.70e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.49e-006 | 8.49e-005 | 0.3607 | 0.30 |
| 90 | 90 | 6.70e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.49e-006 | 8.49e-005 | 0.3608 | 0.30 |
| 100 | 100 | 6.70e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.50e-006 | 8.50e-005 | 0.3608 | 0.30 |
| 110 | 110 | 6.70e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.50e-006 | 8.50e-005 | 0.3609 | 0.30 |
| 120 | 120 | 6.70e+001 | 4.30e+001 | 2.40e+001 | 0.64 | 8.51e-006 | 8.51e-005 | 0.361 | 0.30 |
| 130 | 130 | 6.71e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.52e-006 | 8.52e-005 | 0.3611 | 0.30 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 140 | 140 | 6.71e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.52e-006 | 8.52e-005 | 0.3612 | 0.30 |
| 150 | 150 | 6.71e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.53e-006 | 8.53e-005 | 0.3613 | 0.30 |
| 160 | 160 | 6.71e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.53e-006 | 8.53e-005 | 0.3614 | 0.30 |
| 170 | 170 | 6.71e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.54e-006 | 8.54e-005 | 0.3614 | 0.30 |
| 180 | 180 | 6.71e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.54e-006 | 8.54e-005 | 0.3615 | 0.30 |
| 190 | 190 | 6.71e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.55e-006 | 8.55e-005 | 0.3616 | 0.30 |
| 200 | 200 | 6.71e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.56e-006 | 8.56e-005 | 0.3617 | 0.30 |
| 210 | 210 | 6.72e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.56e-006 | 8.56e-005 | 0.3618 | 0.30 |
| 220 | 220 | 6.72e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.57e-006 | 8.57e-005 | 0.3619 | 0.30 |
| 230 | 230 | 6.72e+001 | 4.31e+001 | 2.40e+001 | 0.64 | 8.57e-006 | 8.57e-005 | 0.362 | 0.30 |
| 240 | 240 | 6.72e+001 | 4.31e+001 | 2.41e+001 | 0.64 | 8.58e-006 | 8.58e-005 | 0.362 | 0.30 |
| 250 | 250 | 6.72e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.58e-006 | 8.58e-005 | 0.3621 | 0.30 |
| 260 | 260 | 6.72e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.59e-006 | 8.59e-005 | 0.3622 | 0.30 |
| 270 | 270 | 6.72e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.60e-006 | 8.60e-005 | 0.3623 | 0.30 |
| 280 | 280 | 6.73e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.60e-006 | 8.60e-005 | 0.3624 | 0.30 |
| 290 | 290 | 6.73e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.61e-006 | 8.61e-005 | 0.3625 | 0.30 |
| 300 | 300 | 6.73e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.61e-006 | 8.61e-005 | 0.3626 | 0.30 |
| 310 | 310 | 6.73e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.62e-006 | 8.62e-005 | 0.3626 | 0.30 |
| 320 | 320 | 6.73e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.63e-006 | 8.63e-005 | 0.3627 | 0.30 |
| 330 | 330 | 6.73e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.63e-006 | 8.63e-005 | 0.3628 | 0.30 |
| 340 | 340 | 6.73e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.64e-006 | 8.64e-005 | 0.3629 | 0.30 |
| 350 | 350 | 6.74e+001 | 4.32e+001 | 2.41e+001 | 0.64 | 8.64e-006 | 8.64e-005 | 0.363 | 0.30 |
| 360 | 360 | 6.74e+001 | 4.33e+001 | 2.41e+001 | 0.64 | 8.65e-006 | 8.65e-005 | 0.3631 | 0.30 |
| 370 | 370 | 6.74e+001 | 4.33e+001 | 2.41e+001 | 0.64 | 8.65e-006 | 8.65e-005 | 0.3632 | 0.30 |
| 380 | 380 | 6.74e+001 | 4.33e+001 | 2.41e+001 | 0.64 | 8.66e-006 | 8.66e-005 | 0.3633 | 0.30 |
| 390 | 390 | 6.74e+001 | 4.33e+001 | 2.41e+001 | 0.64 | 8.67e-006 | 8.67e-005 | 0.3633 | 0.30 |
| 400 | 400 | 6.74e+001 | 4.33e+001 | 2.41e+001 | 0.64 | 8.67e-006 | 8.67e-005 | 0.3634 | 0.30 |
| 410 | 410 | 6.74e+001 | 4.33e+001 | 2.41e+001 | 0.64 | 8.68e-006 | 8.68e-005 | 0.3635 | 0.30 |
| 420 | 420 | 6.74e+001 | 4.33e+001 | 2.41e+001 | 0.64 | 8.68e-006 | 8.68e-005 | 0.3636 | 0.30 |
| 430 | 430 | 6.75e+001 | 4.33e+001 | 2.41e+001 | 0.64 | 8.69e-006 | 8.69e-005 | 0.3637 | 0.30 |
| 440 | 440 | 6.75e+001 | 4.33e+001 | 2.42e+001 | 0.64 | 8.70e-006 | 8.70e-005 | 0.3638 | 0.30 |
| 450 | 450 | 6.75e+001 | 4.33e+001 | 2.42e+001 | 0.64 | 8.70e-006 | 8.70e-005 | 0.3639 | 0.30 |
| 460 | 460 | 6.75e+001 | 4.33e+001 | 2.42e+001 | 0.64 | 8.71e-006 | 8.71e-005 | 0.3639 | 0.30 |
| 470 | 470 | 6.75e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.71e-006 | 8.71e-005 | 0.364 | 0.30 |
| 480 | 480 | 6.75e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.72e-006 | 8.72e-005 | 0.3641 | 0.30 |
| 490 | 490 | 6.75e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.73e-006 | 8.73e-005 | 0.3642 | 0.30 |
| 500 | 500 | 6.76e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.73e-006 | 8.73e-005 | 0.3643 | 0.30 |
| 510 | 510 | 6.76e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.74e-006 | 8.74e-005 | 0.3644 | 0.30 |
| 520 | 520 | 6.76e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.74e-006 | 8.74e-005 | 0.3645 | 0.30 |
| 530 | 530 | 6.76e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.75e-006 | 8.75e-005 | 0.3646 | 0.30 |
| 540 | 540 | 6.76e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.76e-006 | 8.76e-005 | 0.3646 | 0.30 |
| 550 | 550 | 6.76e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.76e-006 | 8.76e-005 | 0.3647 | 0.30 |
| 560 | 560 | 6.76e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.77e-006 | 8.77e-005 | 0.3648 | 0.30 |
| 570 | 570 | 6.77e+001 | 4.34e+001 | 2.42e+001 | 0.64 | 8.77e-006 | 8.77e-005 | 0.3649 | 0.30 |
| 580 | 580 | 6.77e+001 | 4.35e+001 | 2.42e+001 | 0.64 | 8.78e-006 | 8.78e-005 | 0.365 | 0.30 |
| 590 | 590 | 6.77e+001 | 4.35e+001 | 2.42e+001 | 0.64 | 8.79e-006 | 8.79e-005 | 0.3651 | 0.30 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 600 | 600 | 6.77e+001 | 4.35e+001 | 2.42e+001 | 0.64 | 8.79e-006 | 8.79e-005 | 0.3652 | 0.30 |
| 610 | 610 | 6.77e+001 | 4.35e+001 | 2.42e+001 | 0.64 | 8.80e-006 | 8.80e-005 | 0.3653 | 0.30 |
| 620 | 620 | 6.77e+001 | 4.35e+001 | 2.42e+001 | 0.64 | 8.80e-006 | 8.80e-005 | 0.3653 | 0.30 |
| 630 | 630 | 6.77e+001 | 4.35e+001 | 2.42e+001 | 0.64 | 8.81e-006 | 8.81e-005 | 0.3654 | 0.30 |
| 640 | 640 | 6.78e+001 | 4.35e+001 | 2.43e+001 | 0.64 | 8.82e-006 | 8.82e-005 | 0.3655 | 0.30 |
| 650 | 650 | 6.78e+001 | 4.35e+001 | 2.43e+001 | 0.64 | 8.82e-006 | 8.82e-005 | 0.3656 | 0.30 |
| 660 | 660 | 6.78e+001 | 4.35e+001 | 2.43e+001 | 0.64 | 8.83e-006 | 8.83e-005 | 0.3657 | 0.30 |
| 670 | 670 | 6.78e+001 | 4.35e+001 | 2.43e+001 | 0.64 | 8.83e-006 | 8.83e-005 | 0.3658 | 0.30 |
| 680 | 680 | 6.78e+001 | 4.35e+001 | 2.43e+001 | 0.64 | 8.84e-006 | 8.84e-005 | 0.3659 | 0.30 |
| 690 | 690 | 6.78e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.85e-006 | 8.85e-005 | 0.366 | 0.30 |
| 700 | 700 | 6.78e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.85e-006 | 8.85e-005 | 0.3661 | 0.31 |
| 710 | 710 | 6.79e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.86e-006 | 8.86e-005 | 0.3661 | 0.31 |
| 720 | 720 | 6.79e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.86e-006 | 8.86e-005 | 0.3662 | 0.31 |
| 730 | 730 | 6.79e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.87e-006 | 8.87e-005 | 0.3663 | 0.31 |
| 740 | 740 | 6.79e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.88e-006 | 8.88e-005 | 0.3664 | 0.31 |
| 750 | 750 | 6.79e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.88e-006 | 8.88e-005 | 0.3665 | 0.31 |
| 760 | 760 | 6.79e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.89e-006 | 8.89e-005 | 0.3666 | 0.31 |
| 770 | 770 | 6.79e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.89e-006 | 8.89e-005 | 0.3667 | 0.31 |
| 780 | 780 | 6.80e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.90e-006 | 8.90e-005 | 0.3668 | 0.31 |
| 790 | 790 | 6.80e+001 | 4.36e+001 | 2.43e+001 | 0.64 | 8.91e-006 | 8.91e-005 | 0.3669 | 0.31 |
| 800 | 800 | 6.80e+001 | 4.37e+001 | 2.43e+001 | 0.64 | 8.91e-006 | 8.91e-005 | 0.3669 | 0.31 |
| 810 | 810 | 6.80e+001 | 4.37e+001 | 2.43e+001 | 0.64 | 8.92e-006 | 8.92e-005 | 0.367 | 0.31 |
| 820 | 820 | 6.80e+001 | 4.37e+001 | 2.43e+001 | 0.64 | 8.93e-006 | 8.93e-005 | 0.3671 | 0.31 |
| 830 | 830 | 6.80e+001 | 4.37e+001 | 2.43e+001 | 0.64 | 8.93e-006 | 8.93e-005 | 0.3672 | 0.31 |
| 840 | 840 | 6.80e+001 | 4.37e+001 | 2.44e+001 | 0.64 | 8.94e-006 | 8.94e-005 | 0.3673 | 0.31 |
| 850 | 850 | 6.81e+001 | 4.37e+001 | 2.44e+001 | 0.64 | 8.94e-006 | 8.94e-005 | 0.3674 | 0.31 |
| 860 | 860 | 6.81e+001 | 4.37e+001 | 2.44e+001 | 0.64 | 8.95e-006 | 8.95e-005 | 0.3675 | 0.31 |
| 870 | 870 | 6.81e+001 | 4.37e+001 | 2.44e+001 | 0.64 | 8.96e-006 | 8.96e-005 | 0.3676 | 0.31 |
| 880 | 880 | 6.81e+001 | 4.37e+001 | 2.44e+001 | 0.64 | 8.96e-006 | 8.96e-005 | 0.3677 | 0.31 |
| 890 | 890 | 6.81e+001 | 4.37e+001 | 2.44e+001 | 0.64 | 8.97e-006 | 8.97e-005 | 0.3677 | 0.31 |
| 900 | 900 | 6.81e+001 | 4.37e+001 | 2.44e+001 | 0.64 | 8.97e-006 | 8.97e-005 | 0.3678 | 0.31 |
| 910 | 910 | 6.81e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 8.98e-006 | 8.98e-005 | 0.3679 | 0.31 |
| 920 | 920 | 6.82e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 8.99e-006 | 8.99e-005 | 0.368 | 0.31 |
| 930 | 930 | 6.82e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 8.99e-006 | 8.99e-005 | 0.3681 | 0.31 |
| 940 | 940 | 6.82e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 9.00e-006 | 9.00e-005 | 0.3682 | 0.31 |
| 950 | 950 | 6.82e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 9.01e-006 | 9.01e-005 | 0.3683 | 0.31 |
| 960 | 960 | 6.82e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 9.01e-006 | 9.01e-005 | 0.3684 | 0.31 |
| 970 | 970 | 6.82e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 9.02e-006 | 9.02e-005 | 0.3685 | 0.31 |
| 980 | 980 | 6.82e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 9.03e-006 | 9.03e-005 | 0.3686 | 0.31 |
| 990 | 990 | 6.83e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 9.04e-006 | 9.04e-005 | 0.3686 | 0.31 |
| 1000 | 1000 | 6.83e+001 | 4.38e+001 | 2.44e+001 | 0.64 | 9.04e-006 | 9.04e-005 | 0.3687 | 0.31 |

End of pc-CRACK Output

# APPENDIX B

## GE-HITACHI INSPECTION REPORT D2R21-029 DATED 11/10/09

| HITACHI | EXAMINATION SUMMARY SHEET | Report No.: D2R21-029 |
|---|---|---|

Site: Dresden  Component ID: 2/1/02028-28/PS2-TEE/202-4B

Outage: RFO 21  TEE-VLV / 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° Long. | D-010 | N/A | GE-PDI-UT-2 Ver/Rev 4 | DRE-PDI-304-01 | Paul Valden | II | 11/4/2009 |
| 45° Shear | D-009 | N/A | GE-PDI-UT-2 Ver/Rev 4 | DRE-PDI-304-01 | Paul Valden | II | 11/4/2009 |
| 45° Shear | D-008 | N/A | GE-PDI-UT-3 Ver/Rev 2 | CAL-OPTH-068 | Chad Olson | II | 11/4/2009 |

Examination Results:

During the manual ultrasonic examination of the above referenced component, two (2) previously recorded indications were detected utilizing 45° shear and 60° RL search units. No new indications were detected.

The two (2) previously recorded flaws have the following parameters:

| Flaw | L Start | End | Length | Depth / % | Locations |
|---|---|---|---|---|---|
| 1 | 16.2" | 17.9" | 1.70" | 0.36 / 17.1 | Upstream |
| 2 | 68.6" | 71.4" | 2.80" | 0.27" / 12.9 | Upstream |

These dimensions show no change from the previous dimensions for these indications.

No downstream examination due to valve configuration.

50% of the required volume was examined.

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

*DRR 07-04/07-29

Examination results were compared to Data Report 0-008, 009, 010 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 — Prepared By: — Level: — Date: 11/11/09
Utility Review: — Date: 11-8-09

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

RWP: 1001-0A26
Dose: 50 mr.

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HITACHI

# Ultrasonic Calibration and Examination Record
## Manual Piping and Components

Site/Unit: Dresden / 2
Outage: RFO 21

Report Number: D2R21-029
Data Sheet Number: D-009
Linearity Sheet: L-004

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

| | | | | |
|---|---|---|---|---|
| SS | Flat | .9"-2.0" | Calibration | Cal Time |
| Material | Size | Thick | Initial Cal: | 1307 |
| Ultragel II | 07225 | | Cal Check: | N/A |
| Couplant: | Couplant batch | | Cal Check: | N/A |
| 264586 | 100° F | | Final Cal: | 1452 |
| Thermometer S/N | Cal Temp. | | | |

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

### Search Unit Data

| | | |
|---|---|---|
| KBA | 01D63R | .5"/Round |
| Manufacturer: | Serial Number | Size/Shape: |
| 0.45 in. | 45° | 45° |
| Incident Point: | Nominal Angle: | Measured Angle: |

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

### DAC Construction

Scan Direction: Ax
Cal Reflector: 2" Notch
Signal Amplitude: 80%
Signal Sweep: 5.7 Div
Signal dB: 0.9 dB
Sweep 0-10 = 5.000 in Metal Path

### Search Unit Cable

| | | |
|---|---|---|
| RG-174 | 8' | 0 |
| Cable Type: | Length: | Connectors: |

### Instrument Settings

| | | | |
|---|---|---|---|
| Panametrics / Epoch 4 | | 081577402 | |
| Manufacturer/Model: | | Serial Number: | |
| 9.25 us | 0.1228 in./usec. | 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 | P/E |
| Damping: | Reject: | Frequency: | Mode: |

### Calibration Verification

Field Simulator Block S/N: CAL-RHOM-120

| | | |
|---|---|---|
| Reflector | FSDH | N/A |
| Amplitude | 42% | N/A |
| Gain (dB) | 10.0 | N/A |
| Sweep (SD) | 2.2 | N/A |

Acceptable Linearity performed: 10/28/2009

Exam Data for Weld: 2/1/02028-28/PS2-TEE/202-48

TEE-VLV / 28"
Configuration:

| | | |
|---|---|---|
| OD | 90° F | 264586 |
| Exam Surface: | Exam Temp. | Exam Thermometer |

| Axial Circ | UPST DNST | Scan dB | Recordable Indications | Exam Angle |
|---|---|---|---|---|
| Axial | UPST | 13.9 | RI | 45° |
| Circ | UPST | 25.9 | RI | 45° |
| | | | | |
| | | | | |

### Exam Comments / Limitations:

*Circ exam performed on tee side base material only and weld crown with skew angles to examine the additional required exam volume.*
*No recordable indications.*
*Previously recorded indications observed with no changes.*
*No exam performed from downstream side due to component configuration.*
*No new indications were observed. Reference through wall sizing indication data sheet D-008*

Exam Start: 1345 Exam End: 1430

PV Paul Valden II
Initials: Examiner: Level:

RT Ryan Tauchen II
Initials: Examiner 2: Level:

Initial Cal/Exam Date: 11/4/2009

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:

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HITACHI

# Ultrasonic Calibration and Examination Record
## Manual Piping and Components

Site/Unit: Dresden / 2
Outage: RFO 21

Report Number: D2R21-029
Data Sheet Number: D-010
Linearity Sheet: L-005

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

| | | | | |
|---|---|---|---|---|
| SS | Flat | 5"-2.0" | Calibration | Cal Time |
| Material | Size | Thick | Initial Cal: | 1308 |
| Ultragel II | 07225 | | Cal Check: | N/A |
| Couplant: | Couplant batch | | Cal Check: | N/A |
| 264586 | 100° F | | Final Cal: | 1453 |
| Thermometer S/N | Cal Temp. | | | |

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

### Search Unit Data

| | | |
|---|---|---|
| RTD | 05-1495 | 20.5x25 mm/Rect. |
| Manufacturer: | Serial Number | Size/Shape: |
| 0.75 in. | 60° | 60° |
| Incident Point: | Nominal Angle: | Measured Angle: |

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

### DAC Construction

Scan Direction: Ax
Cal Reflector: 2" Notch
Signal Amplitude: 80%
Signal Sweep: 7.2 Div
Signal dB: 32.0 dB
Sweep 0-10 = 5.000 in Metal Path

### Search Unit Cable

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

### Calibration Verification

Field Simulator Block S/N: N/A

| | | |
|---|---|---|
| Reflector | N/A | N/A |
| Amplitude | N/A | N/A |
| Gain (dB) | N/A | N/A |
| Sweep (SD) | N/A | N/A |

Acceptable Linearity performed: 10/28/2009

### Instrument Settings

| | | | |
|---|---|---|---|
| Panametrics / Epoch 4 | | 031538006 | |
| Manufacturer/Model: | | Serial Number: | |
| 12.34 us | 0.2342 in./usec. | 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: 2/3/02020-28/PS2-TEE/202-48

TEE-VLV / 28"
Configuration:

| | | |
|---|---|---|
| OD | 90° F | 264586 |
| Exam Surface: | Exam Temp. | Exam Thermometer |

| Axial Circ | UPST DNST | Scan dB | Recordable Indications | Exam Angle |
|---|---|---|---|---|
| Axial | UPST | 45.0 | NRI | 60° |
| | | | | |
| | | | | |
| | | | | |

### Exam Comments / Limitations:

*No recordable indications.*

*Supplemental 60° RL examination due to single side access.*

*No exam performed from downstream side due to component configuration.*

Exam Start: 1345 Exam End: 1430

P.V. Paul Valden II
Initials: Examiner: Level:

RJT Ryan Touchton II
Initials: Examiner 2: Level:

Initial Cal/Exam Date: 11/4/2009

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:

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HITACHI

# Ultrasonic Calibration and Examination Record
## Manual Piping and Components

Site/Unit: Dresden / 2
Outage: RFO 21

Report Number: D2R21-029
Data Sheet Number: D-008
Linearity Sheet: L-002

Calibration Data for Block: CAL-DPTH-068

| | | | | |
|---|---|---|---|---|
| SS | Flat | 2.0" | Calibration | Cal Time |
| Material | Size | Thick | Initial Cal: | 1529 |
| Ultragel II | 07225 | | Cal Check: | 1552 |
| Couplant: | Couplant batch | | Cal Check: | N/A |
| 264795 | 78° F | | Final Cal: | 1704 |
| Thermometer S/N | Cal Temp. | | | |

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

### Search Unit Data

| | | | |
|---|---|---|---|
| KBA | 01H8D2 | .375"/Round | |
| Manufacturer: | Serial Number | Size/Shape: | |
| 0.3 in. | 45° | 45° | |
| Incident Point: | Nominal Angle: | Measured Angle: | |
| 2.25 MHz | Comp-G | Shear | 1 |
| Frequency: | Style: | Mode: | Elements: |

### DAC Construction

Scan Direction: Ax
Cal Reflector: 1.5" SDH
Signal Amplitude: 80%
Signal Sweep: 5.20 Div
Signal dB: 26.5 dB
Sweep 0-10 = 4.000 in Metal Path

### Search Unit Cable

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

### Instrument Settings

| | | | |
|---|---|---|---|
| Panametrics / Epoch 4 | | 031533905 | |
| Manufacturer/Model: | | Serial Number: | |
| 6.225 us | 0.1252 in./usec. | 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: |

### Calibration Verification

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

| | | |
|---|---|---|
| Reflector | FSDH | N/A |
| Amplitude | 80% | N/A |
| Gain (dB) | 20.1 | N/A |
| Sweep (SD) | 2.6 | N/A |

Acceptable Linearity performed: 10/28/2009

Exam Data for Weld: 2/1/02028-28/PS2-TEE/202-48

TEE-VLV / 28"
Configuration:

| | | |
|---|---|---|
| OD | 90° F | 264795 |
| Exam Surface: | Exam Temp. | Exam Thermometer |

| Axial Circ | UPST DNST | Scan dB | Recordable Indications | Exam Angle |
|---|---|---|---|---|
| Axial | UPST | 32.0 | RI | 45° |
| | | | | |
| | | | | |
| | | | | |

### Exam Comments / Limitations:

*Examination performed for through wall sizing of previously recorded indications.*

Exam Start: 1553 Exam End: 1618

CD Chad Olson II
Initials: Examiner: Level:

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

Initial Cal/Exam Date: 11/4/2009

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:

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HITACHI

**Wall Thickness Profile Sheet**

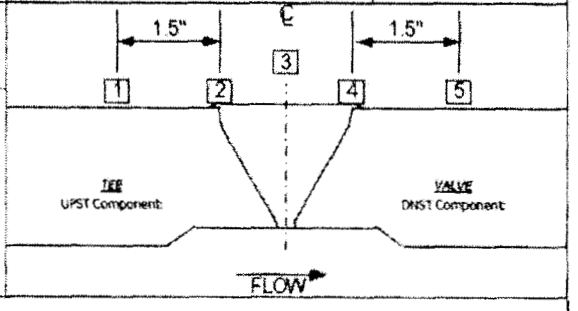
Site: Dresden Unit: 2
Project: RFO 21
Report: D2821-029

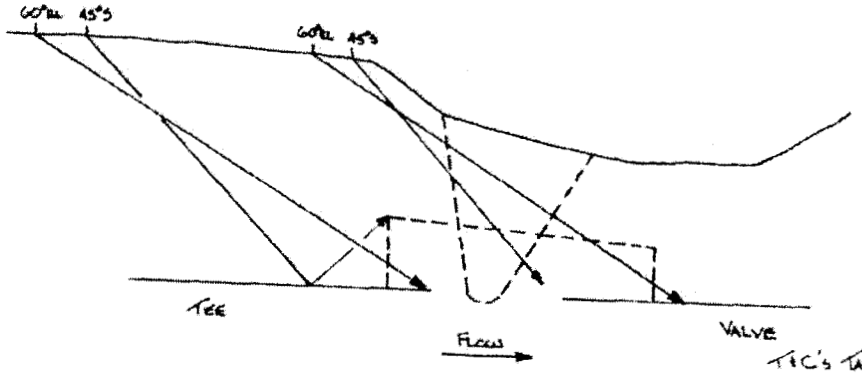
System: RR

| Position | 0° | 90° | 180° | 270° |
|---|---|---|---|---|
| 1 | 2.10" | N/A | N/A | N/A |
| 2 | N/A | N/A | N/A | N/A |
| 3 | 1.32" | N/A | N/A | N/A |
| 4 | 1.10" | N/A | N/A | N/A |
| 5 | 1.12" | N/A | N/A | N/A |

Component ID Number: 2/1/02028-28/PSR-TEE/202-48

Crown Height: .05"
Crown Width: 1.0"
Nominal Diameter: 28.0"
Weld Length: 90.0"




T/C's Taken From Report No. D2820-043 Dated 10/31/07

| Drawn by: | Level: | Date: | GE Reviewed By: | Level: | Date: | Utility Review: | Date: | ANII Review: | Date: |
|---|---|---|---|---|---|---|---|---|---|
| Paul Valdez | II | 11/4/2009 | Scott R Eischen III | II | 11/7/09 | See Summary Sheet for Signature | | See Summary Sheet for Signature | |

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HITACHI

## Ultrasonic Examination Indication Report

Site: Dresden

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

Data Report Number: 02821-029

Cal / Data Sheet Number: D-008

Weld ID: 2/3/02029-RB/PS2-TEE/PS2-4R

Drawing: 103-3

Size: 28"

Thickness: 1.875"

Exam Start: 1553

Lo Location: 180" From Vessel

Wo Location: Weld Centerline

Weld Width: 1.25"

Weld Height: Flush

Exam End: 1618

| 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 | 45 | N/A | 15.2" | 15.6" | 17.9" | N/A | N/A | N/A | N/A | N/A | N/A | Circ | Upst | Indication 0.36" through-wall. No change from previous data. |
| 2 | 45 | N/A | 68.6" | 70.2" | 71.4" | N/A | N/A | N/A | N/A | N/A | N/A | Circ | Upst | Indication 0.27" through-wall. No change from previous data. |

Sketch

CO Chad Olson — Examiner

II — Level

11/4/2009 — Date

Scott R Erchan III — GE Reviewed By

Level

11/7/09 — Date

See Summary Sheet for Signature — Utility Review:

Date:

See Summary Sheet for Signature — ANII Review:

Date:

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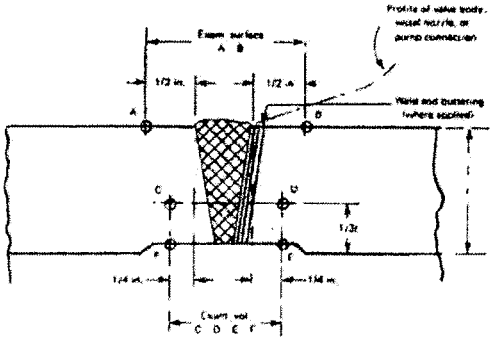
**2/1/0202B-28/PS2-TEE/202-4B** D2R21-029

**Augmented Exam, IGSCC Category F**

**Component: Tee-Valve 28" Dia. 1.82" Nom. Cal Block: DRE-PDI-304-01**

**Procedure: GE-PDI-UT-2,Rev. 4 DRR 07-04 / 07-29; GE-PDI-UT-3,Rev.2**

**Manual Exam**



1) Scan as shown in figure. The absolute minimum scan includes the weld plus 1/4".
2) Examination is single sided. 45° Shear and High angle RL required
3) Scan sensitivity is per procedure.
4) Previous indications observed.
5) Any questions or problems call S. Snyder @ 4262 or S. Erickson @ 4276 ASAP

Prepared By: Scott R Erickson GEH LVII 10/27/2007

Approved By: [illegible] 11-2-07

# APPENDIX C

## DRESDEN TRANSMITTAL OF DESIGN INPUT (TODI) 09-045, "HYDROGEN WATER CHEMISTRY DATA," DATED NOVEMBER 30, 2009

Exelon

| EXELON TRANSMITTAL OF DESIGN INFORMATION | | |
|---|---|---|
| ☒SAFETY-RELATED<br>☐NON-SAFETY-RELATED<br>☐REGULATORY RELATED | Originating Organization<br>☒Exelon<br>☐Other (specify) | TODI No. 09-045 Revision 2 |
| Station Unit(s)<br>System Designation: Dresden Unit 2 | | Page 1 of 3 |
| | | To: H. L. Gustin |

Subject Hydrogen Water Chemistry Data

| | | |
|---|---|---|
| D. Malauskas<br>Preparer | Dan Malauskas<br>Preparer's Signature | 11-30-09<br>Date |
| P. Mankoo<br>Reviewer | P. Mankoo<br>Reviewer's Signature | 11-30-09<br>Date |
| J. Strmec<br>Approver | J. Strmec<br>Approver's Signature | 11-30-09<br>Date |

Status of Information: ☒Approved for Use ☐Unverified

Method and Schedule of Verification for Unverified TODIs:

Description of Information: Water chemistry data needed to select the IGSCC crack growth rate used to perform the evaluation of flaw indications found during ISI examinations. The data is presented on pages 2 and 3.

Purpose of Issuance: Transmit water chemistry data required to perform flaw evaluations

Source Documents:

1. Exelon Inspection Relief Data 2009, Dresden Summary dated 10-31-09,
2. EPRI BWRVIA Radiolysis Model V. 2.0, Molar Ratio vs Feedwater Hydrogen Concentration Output Chart, Dated 11-22-09.

Distribution: H. L. Gustin (Structural Integrity Associates), C. Podczerwinski, T. Loch, J. Strmec, D. Malauskas, P. Mankoo

Exelon.

| EXELON<br>TRANSMITTAL OF DESIGN INFORMATION | TODI NO. 09-045 Revision 2<br>Page 2 of 3 . |
|---|---|

According to the safety evaluation dated January 30, 2001, on the BWRVIP-62 report, the crack growth rate of $1.1 \times 10^{-5}$ in/hr can only be used for units having effective hydrogen water chemistry (HWC) and acceptable noble metal chemical application (NMCA). The criteria for acceptable NMCA: (1) hydrogen vs. oxygen molar ratio is 4:1 and above, (2) monitoring program is required, and (3) is available 90 percent of the time. The following data supports criteria 1-3 above:

Dresden Nuclear Power Station (DNPS) 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. DNPS Unit 2 has been under a NMCA program since the fall of 1999 which supscedes the HWC program.

1. Molar Ratio:

   - The cycle average measured hydrogen to oxygen molar ratio over the last two DNPS Unit 2 cycles was 495:1 for Cycle 20 and 289:1 for Cycle 21 at the measured location against a goal of > 4:1 measured. The measured location is a sample, which is representative of the recirculation loop.
   - As calculated by the EPRI Boiling Water Reactor Vessel and Internals Assessment (BWRVIA) Radiolysis Model, hydrogen is injected into the feedwater at a rate necessary to achieve a hydrogen to oxygen molar ratio of ≥ 3:1 in the Upper Downcomer (DC-UP) which corresponds to a molar ratio of approximately 3.5:1 in the recirculation pipe (RC-END). Chart 1 below provides the output of a recent DNPS Unit 2 BWRVIA model.

2. Monitoring Program:

   - DNPS has an effective monitoring program for determining catalyst loading and predicting reapplication.

3. Hydrogen Availability:

   - 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.

Other mitigation parameters over the last two cycles were as follows:

Electrochemical Corrosion Potential (ECP):

- Electrochemical Corrosion Potential (ECP) over the last two DNPS Unit 2 cycles ranged from -491 to -476 mV (SHE) with a goal of < -230 mV (SHE). ECP is currently monitored in the Noble Metals Monitoring Skid (NMMS), which is located on a side loop off of the reactor water cleanup system.

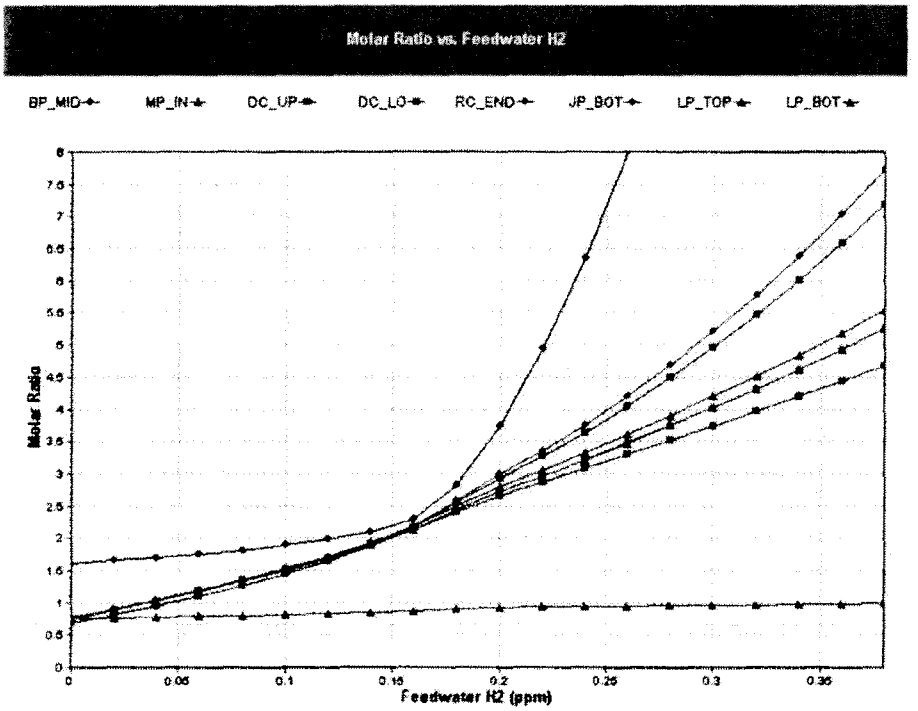
Exelon.

| EXELON<br>TRANSMITTAL OF DESIGN INFORMATION | TODI NO. 09-045 Revision 2<br>Page 3 of 3 |
|---|---|

- 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 DNPS 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.

Chart 1: EPRI BWRVIA V2.0, H2:O2 Molar Ratio vs FW Hydrogen Concentration
Dresden Unit 2



# APPENDIX D

## DRESDEN TRANSMITTAL OF DESIGN INPUT (TODI) 09-048, "VALVE BODY MATERIAL PROPERTIES FOR VALVE 2-0202-4B," DATED NOVEMBER 23, 2009

**EXELON TRANSMITTAL OF DESIGN INFORMATION**

| | | |
|---|---|---|
| ☒SAFETY-RELATED<br>☐NON-SAFETY-RELATED<br>☐REGULATORY RELATED | Originating Organization<br>☒Exelon<br>☐Other (specify) | TODI No. 09-048 |
| Station Unit(s)<br>System Designation: Dresden Unit 2 | | Page 1 of 1<br>To: H. L. Gustin |

Subject Valve Body Material Properties for Valve 2-0202-4B

| | | |
|---|---|---|
| Craig Podczerwinski<br>Preparer | Craig Podczerwinski<br>Preparer's Signature | 11/20/2009<br>Date |
| Jason Forsythe<br>Reviewer | [signature]<br>Reviewer's Signature | 11/23/09<br>Date |
| T. Loch<br>Approver | T. Loch<br>Approver's Signature | 11/23/09<br>Date |

Status of Information: ☒Approved for Use ☐Unverified

Method and Schedule of Verification for Unverified TODIs: Comparison with Source Reports

Description of Information:

Ferrite Number measurements were taken at 12 locations on the outside surface of the body of Recirculation System Valve 0202-4B on 11/20/2009. The measured values ranged from 13 to 17. The average value was 14.6.

The valve body material is A351 Grade CF8M. The Carbon Content of the valve body material was reported to be 0.08% by the Material Certification Sheet referenced below.

Purpose of Issuance:
Provide data for evaluation of the IGSCC resistance of the valve body

Source Documents:
The ferrite number measurements were taken from PowerLabs LLC report DRE-71507. The material specification for the material was taken from Crane Company Report OTC-372 Rev. 1. The carbon content was obtained from the Crane Company Tensile Test Report for Valve 202-4 filed in Exelon record 3893462 located on Microfilm Reel 0016.

Distribution:

H.L. Gustin (Structural Integrity Associates), T. Loch, C. Podczerwinski