

Attachment 1

**"Evaluation of Indication in Peach Bottom Unit 2
Vessel Closure Head Weld (CH-C-2),"
Report Number 0000-0124-0988, September 2010**



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**EVALUATION OF INDICATION IN
PEACH BOTTOM UNIT 2
VESSEL CLOSURE HEAD WELD (CH-C-2)**

(UT Examination P2R18)

Prepared for

Exelon Corp.

Peach Bottom Atomic Power Station, Unit 2

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1 EXECUTIVE SUMMARY

The reactor pressure vessel closure head at Peach Bottom Atomic Power Station, Unit 2 (PBAPS-2) was ultrasonically (UT) examined [Reference 1] during refueling outage eighteen (P2R-18). There were multiple indications/flaws noted in the Closure Head to Flange Weld (CH-C-2) region. All but one of the indications/flaws were classified as being indications/flaws without through wall dimension or were deemed acceptable based on the Section XI, Table IWB-3510-1 [Reference 4]. Therefore the GEH Customer Notification Form [Reference 2] states that this one (1) indication/flaw (Indication #9) will require evaluation with IWB-3600 to allow continued operation.

The Indication/flaw (Indication #9) is in the circumferential weld approximately seventeen (17) inches away from the closest meridional weld and is orientated transverse to the weld in the plate region of the weld. Therefore the flaw/indication is in the same plane (i.e. same orientation) to the meridional weld indications/flaws that were evaluated in 2002 [Reference 3]. Based on the geometry it was determined that the 2002 meridional weld flaw evaluation & method [Reference 3] remains valid/applicable for this Closure Head to Flange weld (CH-C-2) indication/flaw.

This report summarizes the evaluation/comparison that compared the one (1) indication/flaw with through wall dimension and length reported in the PBAPS-2 UT examination [Reference 1] to the allowable indication/flaw depth and length evaluated in the P2-R14 "The Evaluation Of Indications In Peach Bottom Unit 2 Vessel Closure Head For Continued Operation" [Reference 3].

Based on this evaluation/comparison it is concluded that the indication/flaw (Indication #9) found in the PBAPS-2 Closure Head to Flange (Weld CH-C-2) region during the Refueling Outage (P2R-18) UT examination [Reference 1] is acceptable by the flaw acceptance criteria of the ASME Section XI Code [Reference 4]. Therefore, it is concluded that the subject indication/flaw (Indication # 9) in the Closure Head to Flange Weld (CH-C-2) region is acceptable for continued operation in "as-is" condition.

2 INTRODUCTION AND REPORT OUTLINE

2.1. Introduction

In September 2010, GEH Engineering was contacted/contracted to determine if an indication/flaw (Indication #9) reported in the P2R-18 Customer Notification Form [Reference 2] for the Closure Head to Flange Weld (CH-C-2) region could be dispositioned based on the 2002 GE Nuclear Energy (GENE) fracture mechanics evaluation [Reference 3] that meets the IWB-3600 acceptance criteria of the 1989 with no addenda ASME Section XI Code [Reference 5]. It was also requested that GEH determine if the 2002 evaluation [Reference 3] remains applicable if the 2001 with 2003 addenda ASME Section XI Code [Reference 4] was considered. This report summarizes the fracture mechanics and ASME Code evaluation/comparison that was performed to disposition the one (1) indication/flaw (Indication #9) in the Closure Head to Flange Weld (CH-C-2) region.

2.2. Report Outline

Section 3 of this report provides a brief flaw description of the indication/flaw and previous disposition history. It will summarize the UT inspection results and describes the flaw geometry considered in the evaluation. Section 4 summarizes why the 2002 meridional indication/flaw evaluation/methodology [Reference 3] is applicable for the Closure Head to Flange (CH-C-2) indication/flaw (Indication #9). Section 5 provides the results of the fracture mechanics evaluation/comparison of the P2R-18 indication/flaw to the 2002 GE Nuclear Energy (GENE) fracture mechanics evaluation [Reference 3] bounding evaluated indication/flaw size geometry. Finally, summary and conclusions are presented in Section 6.

3 INSPECTION REPORTS SUMMARY AND FLAW GEOMETRY

3.1. Inspection Reports Summary

3.1.1. Peach Bottom, Unit 2 - Refueling Outage Thirteen (P2R-13)

The reactor pressure vessel closure head at Peach Bottom Atomic Power Station, Unit 2 (PBAPS-2) was ultrasonically (UT) examined [Reference 6] during refueling outage thirteen (P2R-13). There were multiple indications/flaws noted in the Closure Head to Flange Weld (CH-C-2) region. All of the indications/flaws were classified as being indications/flaws without through wall dimension or were deemed acceptable based on the Section XI, Table IWB-3510-1 [Reference 5].

Indication #5 was determined to be located at an azimuth location of 660.5 inches. The flaw was detected only while scanning in the CCW direction. The indication's "W" distance (distance from the weld centerline) was 3.1 inches. According to the data sheet, this was a spot indication (meaning that no movement of the search unit was possible without losing the reflector) oriented transverse to the weld. The flaw was evaluated and found to be acceptable, using the limited positional data available. This examination was performed using Pre-PDI examination techniques.

The Indication/flaw geometry was reported as: " $2a$ " = 0.60" (therefore " a " = 0.30"), " l " = 0.60", and " t " = 4.5". This resulted in " a/t " = 6.67% < 7.6% (allowable for " a/l " of 0.50 [Reference 5]). Therefore deemed acceptable based on the Section XI, Table IWB-3510-1 [Reference 5].

3.1.2. Peach Bottom, Unit 2 - Refueling Outage Eighteen (P2R-18)

The reactor pressure vessel closure head at Peach Bottom Atomic Power Station, Unit 2 (PBAPS-2) was ultrasonically (UT) examined [Reference 1] during refueling outage eighteen (P2R-18). There were multiple indications/flaws noted in the Closure Head to Flange Weld (CH-C-2) region. All but one of the indications/flaws were classified as being indications/flaws without through wall dimension or were deemed acceptable based on the Section XI, Table IWB-3510-1 [Reference 4]. Indication #9 was the one (1) indication/flaw that requires additional evaluation with IWB-3600 to allow continued operation.

Indication (#9) was determined to be located at an azimuth of 660 inches. The flaw was detected while scanning in both the CW and CCW directions. The indication's "W" distance (distance from the weld centerline) was ~4.5". The P2R18 data was gathered using a PDI demonstrated examination.

The Indication/flaw was reported as being transverse to the weld and having a geometry of: " $2a$ " = 0.42" (therefore " a " = 0.21"), " l " = 1.00", " t " = 4.5" and " S " = 1.56". This resulted in " a/t " = 4.6% > 3.3% (allowable for " a/l " of 0.20 [Reference 4]). Therefore deemed not acceptable based on the Section XI, Table IWB-3510-1 [Reference 4].

3.1.3. P2R-13 / P2R-18 Indication/Flaw Location Comparison

The location of the indications in P2R13 (Indication #5) versus P2R18 (Indication #9) is well within the measurement accuracy possible for manual examination techniques on RPV Closure Head welds. GE Hitachi has determined that the indications are from the same reflector. The flaw/indication geometries differ due to the newer/more accurate inspection techniques.

3.2. Flaw Geometry

This section discusses the one (1) indication/flaw (Indication #9) that displayed tip signals and possessed a through wall dimension and was classified as exceeding the requirements of Table IWB-3510-1 [Reference 4]. Dimensions of this one (1) indication/flaw are characterized in Table 3-1. The Reactor Pressure Vessel Examination / Reactor Pressure Vessel Sizing Data Sheet can be found in reference 2.

3.2.1. FLAW GEOMETRIES CONSIDERED IN EVALUATION

Figure 3-1 shows the criteria used to determine if the indications/flaws that are to be evaluated need to be characterized as surface or sub-surface type flaws for the purpose of fracture mechanics analysis. Figure 3-1(A) shows the parameters used for surface proximity evaluation. Figure 3-1(B) shows the parameters used for sub-surface proximity evaluation.

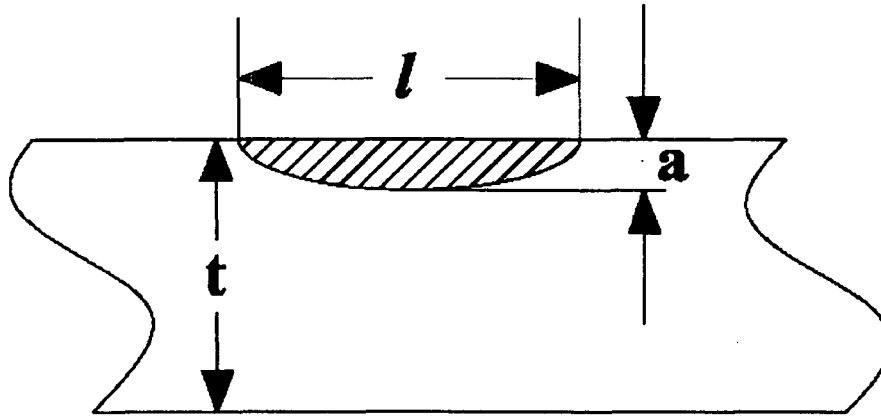
The guidance for this characterization is provided in Article IWA-3000 [Reference 4]. For this evaluation (Closure Head to Flange Weld Flaw Evaluation) the nominal flaw sizes (truncated to the hundredths term) are evaluated/compared to the allowable flaw sizes. This is consistent with the GE method previously accepted by the BWR Vessel & Internals Project (BWRVIP).

It is seen in Table 3-1 that indication #9 is to be characterized as sub-surface indication because ($S > 0.4a$).

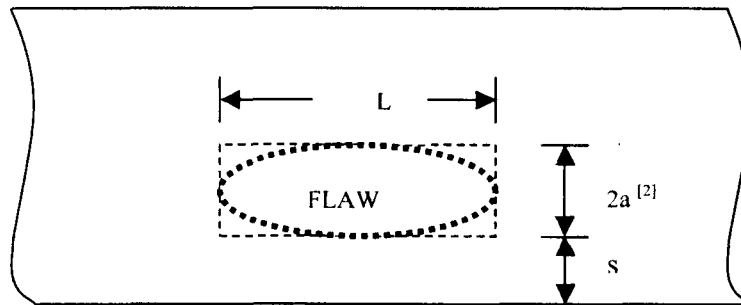
Table 3-1 Listing of Ultrasonic Indication in the Closure Head to Flange Weld (Circumferential Weld CH-C-2) at Peach Bottom Unit 2

Weld ID	IND #	l (in.)	2a (in.)	a (in.)	0.4*a (in.)	S (in.)	a/l
CH-C-2	9 (@308°)	1.00	0.42	0.21	0.084	1.56	0.21

Surface/Subsurface Check: A Flaw characterized as surface flaw if $S < 0.4a$. This is not the case, so flaw is deemed to be sub-surface.



A. OBVIOUS SURFACE FLAW



B. SURFACE or SUB-SURFACE^[1] FLAW

- Notes: [1] Flaw characterized as surface flaw if $S < 0.4a$.
[2] If Classified as Surface Flaw '2a' dimension becomes 'a' for flaw evaluation.

Figure 3-1 Parameters for Surface Proximity Evaluation

4 Meridional Weld Flaw vs. Indication # 9 Flaw Orientation.

4.1. Meridional Weld Indication vs. Circumferential Weld Indication

Indication #9 in the P2R-18 examination [Reference 1] is described as being transverse to the circumferential weld (i.e. going from the flange to the dollar plate) and in the shell section of the weld. The indications in the 2002 GENE fracture mechanics evaluation [Reference 3] are parallel with the meridional weld (i.e. going from the flange to the dollar plate). Therefore indication #9 in the P2R-18 examination [Reference 1] is in the same plane as the meridional welds evaluated in reference 3. This means that the same evaluation methodology and loading would be applicable to both. Therefore the 2002 GENE fracture mechanics evaluation [Reference 3] can be used for evaluation of Indication #9 in the P2R-18 examination [Reference 1] as long as the 2002 bounding evaluation indication's geometry bounds Indication #9's geometry.

**4.2. ASME Section XI Code Comparison
(1989 Edition without addenda vs. 2001 Edition with 2003 addenda)**

4.2.1. Table IWB-3510-1

The two different years of the ASME Section XI, Table IWB-3510-1 [Reference 5 and 4] were compared and determined to be the same. Therefore either code year can be referenced and there is no evaluation modification needed to go from the 1989 Edition without Addenda [Reference 5] to the 2001 Edition with 2003 Addenda [Reference 4].

4.2.2. IWB-3600

The two different years of the ASME Section XI, IWB-3600 through and including IWB-3613 [Reference 5 and 4] were compared and determined to be the same. Therefore either code year can be referenced and there is no evaluation modification needed to go from the 1989 Edition without Addenda [Reference 5] to the 2001 Edition with 2003 Addenda [Reference 4].

5 FRACTURE MECHANICS EVALUATION/REVIEW

5.1. Evaluation / Review Summary

The 2002 GE Nuclear Energy (GENE) fracture mechanics evaluation [Reference 3] was reviewed to determine if the method and evaluation results are applicable/valid to disposition the indication/flaw (Indication #9) in the Closure Head to Flange Weld (CH-C-2).

- The "Assumptions" section (4.1 of the 2002 report) remains applicable/valid.
- The "Applied and Weld Residual Stresses" section (4.2 of the 2002 report) remains applicable/valid.
- The "K Calculation Methodology" section (4.3 of the 2002 report) discusses the "K" calculation being performed for surface flaws. The surface flaw evaluation method considers the flaw through wall depth to be "a". Indication #9 in the CH-C-2 weld is considered to be sub-surface. The sub-surface flaw evaluation method considers the flaw through wall depth to be "2a". This is the only difference in the calculation methodology. Both evaluations use the same equations and input variables. Therefore as long as "a" is what is compared, not the flaw thru wall depth, the evaluations/results are applicable/valid.
- The "Fatigue Crack Growth" section (4.4 of the 2002 report) is conservative as it assumes the indication/flaw is exposed to the reactor water environment.
- The "Allowable K Values" section (4.5 of the 2002 report) remains applicable/valid.

Therefore as long as "a" is what is compared, not the flaw thru wall depth, when comparing the indication #9 geometry to the bounding indication/flaw geometry used in the 2002 GENE fracture mechanics evaluation [Reference 3] evaluation/results is applicable/valid dispositioning the indication/flaw (Indication #9) in the Closure Head to Flange Weld (CH-C-2).

5.2. Indication/Flaw Comparison

The 2002 GENE fracture mechanics evaluation [Reference 3] was performed for a bounding indication/flaw size. The bounding indication/flaw size has a through wall depth ("a") of 0.25", a length ("l") of 3.75" and an "a/l" of 0.067. From looking at Table 3-1, one can see that indication #9 has an "a" depth of 0.21", a length ("l") of 1.0" and an "a/l" of 0.21. Both the ("a" & "l") parameters are bounded by the bounding indication/flaw size and as seen in table 4-1 of Reference 3 the smaller "a/l" ratio, the larger the "K applied", so "a/l" is also bounded. Therefore Indication #9 is bounded by the 2002 GENE fracture mechanics evaluation [Reference 3] that meets the IWB-3600 acceptance criteria of the ASME Section XI Code [Reference 5 & 4] and it is concluded that the subject flaw is acceptable for continued operation in as-is condition.

6 SUMMARY AND CONCLUSIONS

The reactor pressure vessel closure head at Peach Bottom Atomic Power Station, Unit 2 (PBAPS-2) was ultrasonically examined during refueling outage eighteen (P2R-18). There were several indications noted in the Closure Head to Flange Weld (CH-C-2). One (1) indication/flaw displayed tip signals and possessed a through-wall dimension and did not meet the acceptance standards IWB-3510 of ASME Section XI (2001 Edition with 2003 Addenda). The Section XI Code allows for the acceptance of such flaws for continued service if they meet the requirements of Paragraph IWB-3600, Analytical Evaluation of Flaws. A fracture mechanics evaluation, meeting these requirements (for the 1989 Edition without addenda) was performed in 2002 for the Meridional Head Welds for the refueling outage fourteen (P2R-14) UT examination indications/flaws based on a bounding flaw size. The indication/flaw "a" and "l" dimension calculated in the UT examination for P2R-18 were compared to the "a" and "l" dimension used in the 2002 bounding indication/flaw fracture mechanics evaluation.

Based on this evaluation/comparison it is concluded that the indication/flaw (Indication #9) found in PBAPS-2 Closure Head to Flange Weld (CH-C-2) region during the refueling outage (P2R-18) are acceptable by the flaw acceptance criteria of the ASME Section XI Code (for either the 1989 Edition without addenda or the 2001 Edition with 2003 Addenda). The flaw acceptance criteria/methodology of the ASME Section XI Code for the 1989 Edition without addenda and the flaw acceptance criteria of the ASME Section XI Code for the 2001 Edition with 2003 addenda were reviewed and deemed to be the same for this evaluation.

Therefore, it is concluded that the subject indication/flaw (Indication # 9) in the P2R-18 CH-C-2 weld, even after accounting for projected crack growth for the life of the plant including license renewal (60 total years), is acceptable for continued operation in as-is condition using the flaw evaluation acceptance criteria methodology of IWB-3600 in the ASME Section XI Code, 2001 Edition with 2003 addenda.

7 REFERENCES

- [1] GE Nuclear Energy, Peach Bottom Unit 2 – P2R18 UT Examination Report # 008700 for Weld ID – CH-C-2 Closure Head to Flange Weld. Preliminary report Contained in GEH DRFneFile 0000-0124-0995. Official report to be contained in GEH DRF 0000-0122-9171.
- [2] GEH Nuclear Energy (RE: Wade Miller), Peach Bottom Unit 2 – P2R18 UT Customer Notification Form # CNF-016 R1, Project # 168975, WO No: C0231094-06 for Weld ID – CH-C-2 (Closure Head to Flange Weld), September, 27, 2010. Contained in GEH DRFneFile 0000-0124-0995.
- [3] GE Nuclear Energy (RE: S. Kleinsmith), "The Evaluation Of Indications In Peach Bottom Unit 2 Vessel Closure Head For Continued Operation", GENE, San Jose, CA, Report No. 0000-0007-9747, Revision 1, Dated September 2002.
- [4] ASME Boiler and Pressure Vessel Code, Section XI, Rules for In-Service Inspection of Nuclear Power Plant Components, ASME, 2001 Edition with 2003 Addenda.
- [5] ASME Boiler and Pressure Vessel Code, Section XI, Rules for In-Service Inspection of Nuclear Power Plant Components, ASME, 1989 Edition without Addenda.
- [6] GE Nuclear Energy, Peach Bottom Unit 2 – P2R13 UT Examination Report # 008700 for Weld ID – CH-C-2 Closure Head to Flange Weld. Contained in GEH DRFneFile 0000-0124-0995.