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10 CFR 50.55a

2130-06-20383
August 14, 2006

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

Oyster Creek Generating Station
Facility License No. DPR-16
Docket No. 50-219

Subject: Response to Request for Additional Information - Proposed Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel

References:

1) AmerGen letter 2130-00-20300 dated November 10, 2000, "Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
2) AmerGen letter 2130-00-20304 dated November 14, 2000, "Modification to Proposed Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
3) USNRC letter dated November 16, 2000, "Request to Use an Alternative Repair of the Control Rod Drive Housing Interface with the Reactor Vessel at the Oyster Creek Nuclear Generating Station (TAC NO. MB0461)"
4) AmerGen letter 2130-01-20031 dated January 19, 2001, "Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel - Clarification of Leakage Inspection"
5) USNRC letter dated January 8, 2002, "Oyster Creek Nuclear Generating Station – Clarification of Leakage Inspection (TAC NO. MB1065)"
6) AmerGen letter 2130-02-20214 dated July 26, 2002, "Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
7) AmerGen letter 2130-02-20291 dated October 4, 2002, "Additional Information - Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel (TAC No. MB5700)"
8) USNRC letter dated October 18, 2002, "Oyster Creek Nuclear Generating Station - Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel (TAC NO. MB5700)"
9) AmerGen letter 2130-03-20271 dated October 21, 2003, "Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
10) AmerGen letter 2130-04-20157 dated July 20, 2004, "Response to Request for Additional Information Concerning Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
11) AmerGen letter 2130-04-20201 dated August 23, 2004, "Response to Request for Additional Information Concerning Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"

12) AmerGen letter 2130-04-20214 dated September 8, 2004, "Response to Request for Additional Information Concerning Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
13) USNRC letter dated November 12, 2004, "Oyster Creek Nuclear Generating Station - Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel (TAC NO. MC1099)"
14) AmerGen letter 2130-06-20297 dated March 31, 2006, "Proposed Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel – Draft Code Case N-730, 'Roll-Expansion of Class 1 Control Rod Drive Bottom Head Penetrations in BWRs, Section XI, Division 1' "
15) AmerGen letter 2130-06-20355 dated June 23, 2006, "Response to Request for Additional Information – Proposed Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel "

In the Reference 14 letter, AmerGen Energy Company, LLC (AmerGen) requested a proposed alternative to the requirements of ASME Section XI, 1995 Edition through 1996 Addenda, IWA-4000, "Repair/Replacement Activities," for the repair of CRD housing penetrations 42-43 and 46-39 at the Oyster Creek Generating Station. Specifically, AmerGen proposes the use of Draft Code Case N-730, "Roll-Expansion of Class 1 Control Rod Drive Bottom Head Penetrations in BWRs, Section XI, Division 1." Additionally, AmerGen requested approval of the code case as an alternative repair for any additional penetrations that may exhibit leakage for the remainder of the Oyster Creek Generating Station Fourth Ten-Year Inservice Inspection Interval.

In the Reference 15 letter, AmerGen provided our response to the NRC staff's request for additional information discussed with the NRC staff on June 15, 2006. In a conference call with the NRC staff on July 20, 2006, additional information was requested. Attached is our response to your request.

If you should have any questions, please contact Mr. Tom Loomis at 610-765-5510.

Very truly yours,

Pamela B. Cowan
Director – Licensing & Regulatory Affairs
AmerGen Energy Company, LLC

Attachment: 1) Response to Request for Additional Information
2) "Evaluation of the CRD Roll Repair at Oyster Creek," XGEN-2006-08 Rev. 0, July 2006

cc: S. J. Collins, USNRC, Administrator, Region I
G. E. Miller, USNRC, Project Manager, Oyster Creek
M. S. Ferdas, USNRC, Senior Resident Inspector, Oyster Creek
File No. 06028

ATTACHMENT 1

Oyster Creek Generating Station

Response to Request for Additional Information

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

As discussed in a conference call with the NRC on July 20, 2006, a list of bounding values were identified by Oyster Creek Generating Station (OCGS) in the generic Fracture Mechanics Evaluation of a Postulated Crack in the Attachment Weld in Appendix A of the Code Case N-730 Technical Basis Report ("Technical Basis for ASME Code Case N-730 Roll-Expansion of Class 1 Control Rod Drive (CRD) Bottom Head Penetrations in BWRs, Section XI, Division 1," Report XGEN-2005-10, Revision 2, March 2006). The list and the corresponding OCGS values are as follows:

Values	OYSTER CREEK
1. Stub tube to vessel attachment weld is alloy 182	The OCGS stub tube to vessel attachment weld is alloy 182
2. Radius of the bottom head: 100 inches	106"
3. Thickness of bottom head is 6"	8¾"
4. Operating pressure is 1050 psi	1020 psi
5. Limiting RTndt of bottom head = 40°F	45°F
6. Pressure test temperature is 180°F	225°F @ 1020 psig
7. Appendix A, Page 52 - Assumes stress corrosion cracking. "Most BWRs operate with hydrogen water chemistry…."	OCGS utilizes Noble Metals Chemical Addition and Hydrogen Water Chemistry
8. Appendix A, Page 53 - total number of heatup/cooldown cycles is less than 810 cycles	Total number of heatup/cooldown cycles is limited to 240 total for OCGS

In addition to the above values, OCGS was requested to calculate the minimum roll band length (Section 4.3.1, "Roll Expansion Parameter") and the total applied stress intensity factor (Appendix A, Section A-2, "Applied Stress Intensity Factor"). Attachment 2 provides the results of these calculations. As shown in Attachment 2, the OCGS roll repair is bounded by the generic fracture mechanics evaluation.

ATTACHMENT 2

Oyster Creek Generating Station

"Evaluation of the CRD Roll Repair at Oyster Creek"

XGEN-2006-08 Rev.0
July 2006

Evaluation of the CRD Roll Repair at Oyster Creek

Prepared by

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July 2006

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Evaluation of the CRD Roll Repair at Oyster Creek

1. Introduction

Leakage was reported in two control rod drive penetrations in the region of the stub tube weld at Oyster Creek during the Fall 2000 refueling outage. The leakage was observed in Housing No. 42-43 (Penetration Q1) and Housing No. 46-39 (Penetration R2). The configuration of the penetrations is shown in Figure 1. The stub tube is made of Type 304 stainless steel. Because of concerns about furnace sensitization during vessel post weld heat treatment, the stub tube was clad with Type 308 stainless steel weld metal. The stub tube is welded to the low alloy steel vessel bottom head with an Alloy 182 weld. Since cracking is unlikely in the clad stub tube, the most likely location of the leakage was the Alloy 182 weld. The observed leakage was minor (Table 1). The two housings were successfully repaired by roll expansion and the plant has operated without any leakage during the past six years. The roll repair has been approved by the NRC on a cycle to cycle basis.

As part of the approval process for continued operation with the two roll repairs the NRC recommended that Oyster Creek should work on an ASME Code Case to justify long term operation with the roll repair. ASME approval and NRC acceptance of the Code Case would allow long term operation with the roll repair without requiring cycle to cycle approval from the NRC. Since then, ASME Code Case N-730 (Reference 1) has been prepared and has been approved by the ASME Standards Committee (ASME main committee) and is on the Agenda for consideration for final approval by the Board of Nuclear Codes and Standards (BNCS) at the September meeting. Approval by the BNCS will allow formal issuance of Code Case N-730. The NRC staff has reviewed the Code Case in detail during various stages of its development and all NRC concerns have been addressed in the latest draft as approved by the ASME Standards Committee.

This report describes the assessment of the Oyster Creek CRD roll repair and evaluates its conformance with the requirements of Code Case N-730. It also demonstrates that the Oyster Creek design is conservative relative to the fracture mechanics assessment described in the technical basis document (Reference 2). Essentially the analysis described here shows that the conclusions on the inherent fracture margin in Reference 2 are applicable for the Oyster Creek vessel.

2. Oyster Creek Roll Repair Design

The roll repair at Oyster Creek used a roll band length of 4.5 inches and wall thinning of 6%. Figure 2 shows the schematic of the roll repair detail. Subtracting conservatively the roller end radius (¾ inch) at each end of the roll band, the roll band length with the full 6% wall thinning is 3 inches. Table 2 shows the CRD scram loads (from Reference 3) for the different plant conditions. The bounding scram load of 13 kips per CRD is used for the determination of the required roll band length.

Code Case N-730 defines the minimum roll band length (L) required to resist the end-of-scram loads as:

$L = (SF)\ F / [0.4\pi\ (1\text{-}p) \times T \times Sy]$,
where:

F = Maximum upward end-of-scram force, Kips
SF = Structural Factor = 2
p = Nominal wall thinning Fraction (e.g. 0.04 for 4% thinning)
T = Thickness of housing, in.
Sy = Yield strength of the housing material at room temperature, ksi

Substituting F (including the structural factor of 2) = 26 kips, p=0.06, T = 0.5 in and Sy = 30 ksi (Code minimum value at room temperature), the required roll band length is determined to be 1.47 in. The actual roll band length (3 inches after excluding the roll radius region) is in excess of the minimum requirement.

All other requirements of the Code case are also met. Thus, the Oyster Creek roll repair meets all the requirements of Code Case N-730. The fact that the plant has operated successfully without leakage for almost 6 years provides further assurance that the roll repair has been effective.

3. Oyster Creek Fracture Margin

Appendix A of Reference 2 describes a generic fracture mechanics assessment of a potential crack in the stub tube to vessel attachment weld. The conclusion from the analysis was that even with the assumption that the there is a through thickness crack in the Alloy 182 weld, sufficient fracture margins would be assured for the 40 year remaining life of the vessel. The analysis considered crack growth due to fatigue as well as stress corrosion cracking in the low alloy steel bottom head. The parameters for the Oyster Creek vessel are somewhat different than those assumed in the generic assessment of Reference 2, but the differences in most cases, are on the conservative side as described below.

Table 3 compares the different fracture parameters in the generic assessment and Oyster Creek. The key parameters where the differences are significant are:

- The bottom head thickness at Oyster Creek is 8 ¾ inch compared to the 6 inch thickness assumed in the generic assessment. The radius of the bottom head at Oyster Creek (106 inches) is slightly higher than the value (100 inches) used in the generic assessment. However, the higher stress resulting from the slightly higher radius is more than offset by the lower stress resulting from the higher thickness. Thus the nominal pressure stresses are lower for the Oyster Creek vessel than that in the generic assessment. As shown in Table 3, the nominal bottom head pressure stress is 6.18 ksi when compared to the 8.75 ksi assumed in the generic analysis. The Oyster Creek vessel stress is 30% lower than that in the generic analysis.

- The number of thermal cycles is significantly lower at Oyster Creek. Also, Oyster Creek operates with hydrogen water chemistry and noble metals chemical addition (NMCA) compared to the normal water chemistry assumed in the generic analysis. Thus, the predicted crack growth will be significantly lower at Oyster Creek than that assumed in the generic analysis.

- Since the clad stress intensity factor becomes negligible with higher crack size, the main contributor to the crack driving force is the stress intensity factor due to pressure. Since the pressure stress is 30% lower, the applied stress intensity factor at Oyster Creek is 30% lower than in the generic analysis.

- The bottom head vessel RTndt is slightly higher at Oyster Creek (45°F) than that assumed in the generic analysis (40°F). However, the vessel pressure test temperature at Oyster Creek is higher (225°F) than that assumed in the generic analysis (180°F). As shown in Reference 2, the available crack arrest fracture toughness (K_{Ia}) for low alloy steel is given by:

  $K_{Ia} = 26.8 + 12.445 \exp(0.0145(T-RT_{NDT}))$

  Where K_{Ia} is the crack arrest fracture toughness in ksi√inch, T is the pressure test temperature, °F and RTndt is the reference nil-ductility transition temperature of the bottom head, °F.

  Substituting the values for Oyster Creek, the available toughness is 196.0 ksi√inch when compared with the 121.6 ksi√inch assumed in Reference 2. Thus, the available toughness is 40% higher at Oyster Creek

Based on the comparison in Table 3 (and as described above), the applied stress intensity factor is 30% lower at Oyster Creek. Furthermore, the available fracture toughness is 40% higher. Clearly, the fracture margin at Oyster Creek is significantly higher than that in the generic analysis. The conclusions on the inherent fracture integrity in Reference 2 are applicable to Oyster Creek also with additional conservatism.

4. Conclusions

Based on the assessment described in this report, it is concluded that Oyster Creek meets all the requirements of the proposed Code Case N-730. Furthermore, the comparison of the fracture mechanics margin of the Oyster Creek vessel bottom head and the vessel assumed in the generic assessment shows that the fracture margins are higher at Oyster Creek. Thus, the conclusions on the inherent fracture integrity in Reference 2 are applicable to Oyster Creek also with additional conservatism.

5. References

1. Draft Code Case N-730, Roll-Expansion of Class 1 Control Rod Drive Bottom Head Penetrations in BWRs, Section XI, Division 1

2. Technical Basis for ASME Code Case N-730, Roll-Expansion of Class 1 Control Rod Drive (CRD) Bottom Head Penetrations in BWRs, Section XI Division 1, Report XGEN-2005-10 Rev.2, XGEN engineering, San Jose CA.

3. GE Drawing 237E438

Table 1 CRD Rolling History Record

Housing No.	Penetration No.	Date	Roll Band Length, in.	Percent Wall Thinning	Leakage prior to Roll Repair drops/min (DPM)
42-43	Q1	11/11/2000	4.5	6%	160
46-39	R2	11/12/2000	4.5	6%	10

Table 2 CRD Scram Loads (per drive)

Event Description	Load Magnitude, Kips	Load Direction
Scram Reaction – normal startup	3.2	Downward through housing to vessel bottom head and skirt
Scram Reaction – stuck rod	13	To housing only
Scram Reaction – end of stroke	7	Upward through housing and vessel head

Table 3 Comparison of the Fracture Parameters (Generic Assessment vs. Oyster Creek)

Fracture Parameter/attribute	Generic Assessment	Oyster Creek
Stub tube to vessel attachment weld material Alloy 182	Alloy 182	Alloy 182
Radius of the bottom head	100 in.	106 in.
Thickness of bottom head	6 in.	8 ¾"
Operating pressure	1050 psi	1020 psi
Limiting RTndt of bottom head	40 degrees F	45 degrees F
Pressure test temperature	180 degrees F	225 degrees @ 1020 psig
Appendix A, Page 52 = Assumes stress corrosion cracking. "Most BWRs operate with hydrogen water chemistry…."	Normal Water Chemistry	Noble Metals Chemical Addition and Hydrogen Water Chemistry
Appendix A, Page 53 : Number of Cycles	Number of cycles – total cycles = 810 cycles	Total number of heatup/cooldown cycles is limited to 240 total
Bottom head nominal stress	8.75 ksi	6.18 ksi
Available fracture toughness (KIa) during pressure test	121.6 ksi√inch	196.0 ksi√inch

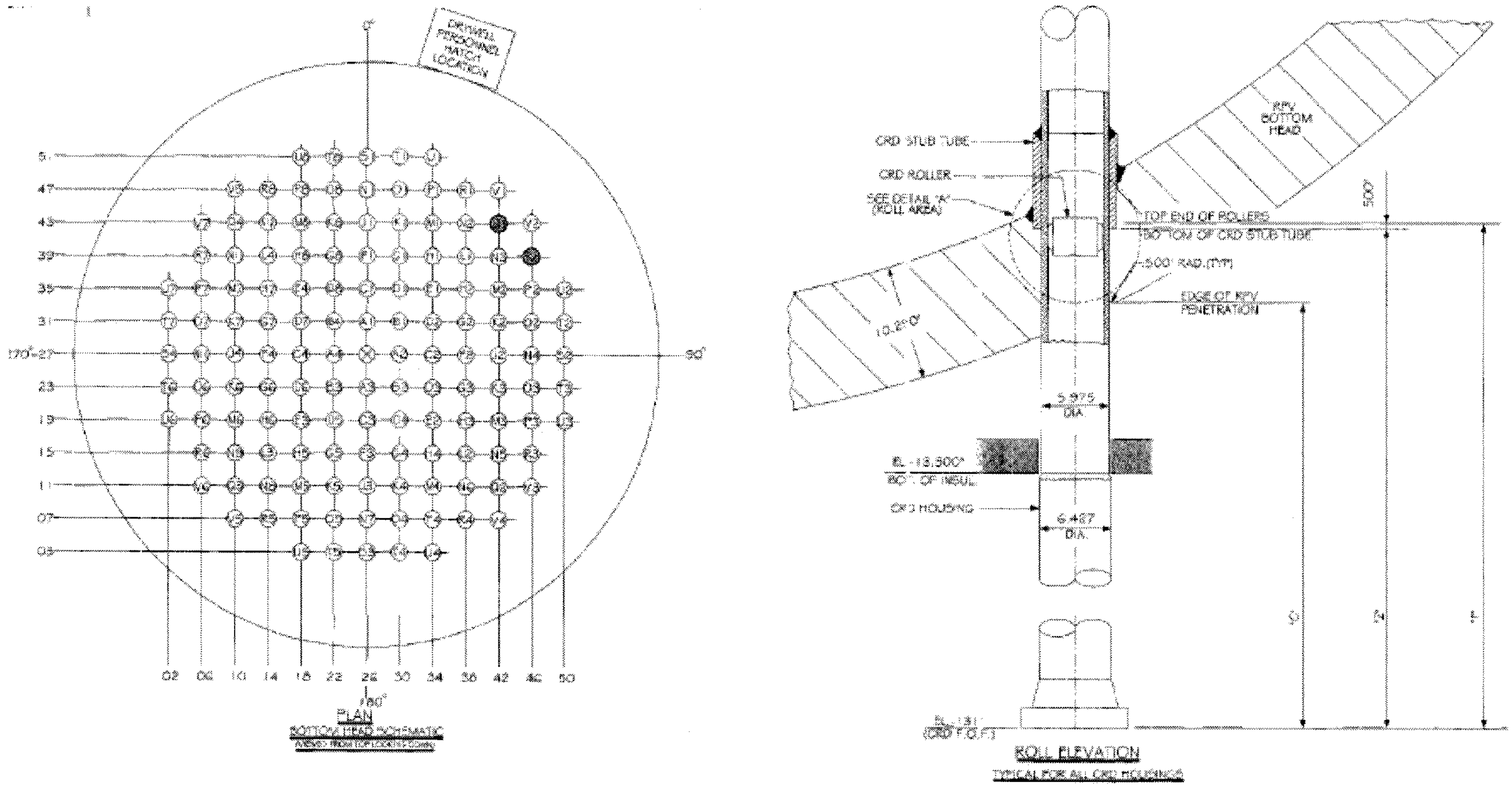

Figure 1 Schematic Figure Illustrating the details of the Roll Repair

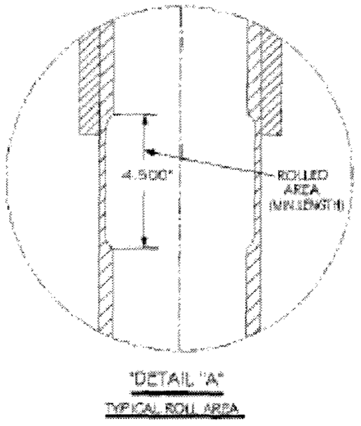

Figure 2 Roll Band Region