BWR OWNERS' GROUP

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BWROG-12022
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Project No. 691

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

Attention: Mr. Joe Golla (NRC)

SUBJECT: Submittal Responses to Request for Additional Information Regarding Boiling Water Reactor Owners' Group (BWROG) Licensing Topical Report BWROG-TP-11-022, Revision 1, Pressure-Temperature Limits Report Methodology for Boiling Water Reactors (TAC NO. ME7649)

ENCLOSURES: 1. Responses to Request for Additional Information Regarding Boiling Water Reactor Owners' Group Licensing Topical Report BWROG-TP-11-022, Revision 1, Pressure-Temperature Limits Report Methodology for Boiling Water Reactors (TAC NO. ME7649)

REFERENCES: 1. Request for Additional Information Regarding Boiling Water Reactor Owners' Group Licensing Topical Report BWROG-TP-11-022, Revision 1, Pressure-Temperature Limits Report Methodology for Boiling Water Reactors (TAC NO. ME7649)

2. BWROG-TP-11-022 (SIR-05-044), "Pressure Temperature Limits Report Methodology for Boiling Water Reactors", Revision 1, November 2011

Dear Mr. Golla:

The BWROG is submitting for your review the enclosed responses to Request for Additional Information (RAI) regarding BWROG Licensing Topical Report (LTR) BWROG-TP-11-022, Revision 1, Pressure-Temperature Limits Report Methodology for Boiling Water Reactors (TAC NO. ME7649).

The RAI responses provided herein are associated with BWROG-TP-11-022 (SIR-05-044), Revision 1, the proposed revision to the approved LTR (SIR-05-044-A, Rev. 0). The LTR addresses Nuclear Regulatory Commission (NRC) Generic Letter (GL) 96-03, allowing plants to relocate their pressure-temperature (P-T) curves and numerical values of other P-T limits (such as heatup/cooldown rates) from the plant Technical Specifications to a Pressure Temperature

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Limits Report (PTLR), which is a licensee-controlled document. The revised LTR documents the Structural Integrity (SI) fracture mechanics methods to reactor pressure vessel (RPV) P-T curve development and approval. The revised LTR also includes treatment of nozzles in the beltline region and some minor editorial clarifications. This LTR can be referenced by any BWR licensee who desires to use the SI methodology for their P-T curve development in a license amendment request to adopt GL 96-03 requirements for a PTLR. This LTR and the response to RAIs are non-proprietary as determined by the author.

We look forward to your timely review of the RAI responses, and to receiving a draft Safety Evaluation if there are no additional concerns. We would be happy to meet with you to discuss any issues. Should you have additional questions regarding this submittal, please contact me or Lucas Martins (BWROG – Project Manager) at (910) 819-1986.

Regards,

Frederick P. "Ted" Schiffley, II
Chairman
BWR Owners' Group

cc: C.J. Nichols, BWROG Program Manager
L. Martins, BWROG Project Manager
BWROG Primary Representatives

ENCLOSURE 1

BWROG-12022

Responses to Request for Additional Information Regarding Boiling Water Reactor Owners' Group Licensing Topical Report BWROG-TP-11-022, Revision 1, Pressure-Temperature Limits Report Methodology for Boiling Water Reactors (TAC NO. ME7649)

RAI-1

Section 2.5.3 of Licensing Topical Report (LTR) BWROG-TP-11-022 (SIR-05-044), Revision 1, "Pressure-Temperature Limits Report Methodology for Boiling Water Reactors [(BWRs)]," provides a new equation (Equation (2.5.3-3a)), along with the existing equation (Equation (2.5.3-3b)), to calculate the thermal stress intensity factor (K_{It}) at the one-quarter thickness (1/4T) location of a postulated axial flaw in a nozzle corner. The LTR states that, "either Equation 2.5.3-3a or 2.5.3-3b may be used for any nozzle configuration in a BWR." The LTR's stated reason for allowing applicants to choose either of the equations arbitrarily is that, "the two formulations differ very little and in fact provide K_I values which differ only by approximately 5%."

As indicated in the ORNL/TM-2010/246 report, "Stress and Fracture Mechanics Analyses of Boiling Water Reactor and Pressurized Water Reactor Pressure Vessel Nozzles," Equation (2.5.3-3a) is for a nozzle with a sharp corner and Equation (2.5.3-3b) is for a nozzle with a rounded corner. Suggesting that applicants use either of the two equations arbitrarily and regardless of the nozzle's geometry is not appropriate because the nozzles with a variety of geometries should not get the 5 percent advantage uniformly simply because it is valid for a nozzle of a specific geometry. Please provide adequate justification for this, or consider the following alternatives: (1) establish a guideline regarding use of these two equations for different nozzle types similar to the ORNL/TM-2010/246 report approach, or (2) use only one equation that always generates conservative results for all nozzles. Quantitative information should be used to support your choice. In addition, based on your choice, Equation (2.5.3-5a) and Equation (2.5.3-5b) need also to be revised accordingly.

Response

ORNL/TM-2010/246 does not provide a technical basis for the assertion that Equation (2.5.3-3a) is for a nozzle with a sharp corner and Equation (2.5.3-3b) is for a nozzle with a rounded corner. The basic formulation for both equations was originally developed in EPRI NP-339, "Improved Evaluation of Nozzle Corner Cracking," which evaluates feedwater nozzles in a BWR. The quarter-crack in an infinite quarter-space and the half-crack in an infinite half-space model spans the range of potential postulated cracking (i.e. 90° to 180° inclusive). In Section 5.2.1 of that report, the authors note that it was anticipated "that these two bounds would not be far apart." EPRI NP-339 concludes that, "Typically, the two models give stress intensity factor values that differ by less than 5%..." This conclusion, given in EPRI NP-339, Section 5.2.1, is the basis for the LTR statement that, "the two formulations differ very little and in fact provide K_I values which differ only by approximately 5%." Further, the LTR statement can be confirmed by comparison of the influence function coefficients given for the LTR Equations (2.5.3-3a) and (2.5.3-3b). The two solutions were both offered as possible solutions for the nozzle corner crack configuration; neither was suggested as being more appropriate for a specific configuration than the other.

RAI-2

Regarding the nozzle corner flaw stress intensity factor due to pressure (K_{Ip}), Section 2.5.3 of the LTR provides a new equation (Equation (2.5.3-5c)) based on Appendix 5 of Welding Research Council (WRC) Bulletin No. 175, "PVRC Recommendations on Toughness Requirements for Ferritic Materials," as an alternative to calculate this value. Although the proposed alternative is based on a three dimensional finite element method (FEM) modeling of a nozzle, considerable progress has been made in fracture mechanics and FEM techniques since the publication of WRC-175 and could potentially make the WRC-175 approach on nozzles unacceptable in the future. Please clarify whether you elect to maintain your position in LTR SIR-05-044-A, or provide a comparison of results from all approaches, demonstrating that the WRC-175 nozzle approach can still provide conservative K_{Ip} results. If the BWROG decides to drop the new equation, a paragraph may be added to state that Appendix G of American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI currently permits use of the WRC-175 approach for nozzles.

Response

10CFR 50.55(a) accepts Section XI, Appendix G without exception. Section XI, Appendix G references the WRC-175 Section 5.C(2) methodology for a corner cracked nozzle subjected to an internal pressure load case as an acceptable methodology for nozzle evaluations. Therefore, the appropriateness of the WRC-175 methodology for corner cracked nozzles is already considered accepted by the US NRC.

RAI-3

Section 2.5.3 of the LTR addresses nozzles in the beltline region. One of the general guidelines regards disposition of the nozzle section with thickness equal to or less than 2.5 inches:

> *For those nozzle inserts which are ferritic the exemption given in ASME XI, Appendix G, paragraph G-2223(c) is generally applicable in which "fracture toughness analysis to demonstrate protection against nonductile failure is not required for portions of nozzles and appurtenances having a thickness of 2.5 inches or less, provided the lowest service temperature is not lower than RTNDT plus 60 °F."*

Based on the NRC staff's experience of reviewing license renewal applications, the NRC staff found that some applicants missed the second half of paragraph G-2223(c) regarding the lowest service temperature. Therefore, the NRC staff suggests the BWROG add some verbiage that would highlight the condition on the lowest service temperature. Please provide this in response to this RAI.

Response

Further clarification will be added to the LTR regarding nozzles in the beltline. The adjusted reference temperature (ART) plus 60 °F, for ferritic nozzles in the beltline, is the appropriate limit for comparison with the lowest service temperature, rather than RTNDT plus 60 °F as currently stated in ASME XI, Appendix G, subparagraph G-2223(c).

The following changes, as identified in underlined text, will be made to the second to last paragraph of Section 2.5.3, on page 2-21 of BWROG-TP-11-022 (SIR-05-044), Revision 1:

> For some nozzle configurations, such as the water level instrument (WLI) nozzle in some BWRs, which is present in the beltline of some BWRs, the nozzle assembly consists of an insert attached to the RPV with a partial penetration weld. The nozzle insert material varies from plant to plant and can be Alloy 600, Stainless Steel, or <u>Carbon or Low Alloy Steel</u>. Those nozzle inserts which are not ferritic do not need to be specifically evaluated; however, the effect of the penetration on the adjacent shell must be considered. For those nozzle inserts which are ferritic the exemption given in ASME XI, Appendix G, paragraph G-2223(c) is generally applicable in which "fracture toughness analysis to demonstrate protection against nonductile failure is not required for portions of nozzles and appurtenances having a thickness of 2.5 inches or less, provided the lowest service temperature is not lower than RTNDT plus 60 °F." <u>The ART plus 60 °F, for ferritic nozzles in the beltline, is the appropriate limit for comparison with the lowest service temperature, rather than RTNDT plus 60 °F as currently stated in ASME XI, Appendix G, subparagraph G-2223(c).</u> A typical partial penetration style WLI nozzle configuration is shown in Figure 2-9.