Edition Number Two 2009

RPV INTEGRITY
Newsletter

Structural Integrity Associates, Inc.

Introduction

Welcome to the second edition of our RPV Integrity Newsletter. This newsletter presents various bits of information that we have gathered while working on industry projects and attending conferences and meetings. We hope that you find it to be a valuable source of information on RPV materials degradation and integrity issues.

In This Issue

SI Capabilities on RPV and PWR Internals Integrity Issues

Utilities are often surprised by some of the work SI routinely performs in the area of RPV and internals integrity. Here is a summary of the type of work we perform in this field:

Pressure – Temperature Curves
- P-T curve development
- P-T Limits Report (PTLR) preparation
- Alternate RPV cooldown/heat-up procedures
- Training on reactor vessel integrity and P-T limit curves

Materials Characterization
- Materials evaluation in accordance with Regulatory Guide 1.99, Revision 2
- BWRVIP Integrated Surveillance Program (ISP) implementation
- Third party review of surveillance program results or implementation
- Projected vessel properties and P-T limits for license renewal applications
- Upper shelf energy (equivalent margins) assessment for vessel end-of-life and for license renewal

PWR Integrity
- Low Temperature Over Pressure (LTOP) protection setpoint evaluation
- Pressurized Thermal Shock (PTS) evaluation

Development, implementation, and independent review of NEI-03-08 programs

Development of aging management programs for PWR vessel internals using MRP-227

Vessel fluence evaluation
- TransWare Enterprises, Inc. is on SI's approved vendor list

So, whatever your needs are in terms of RPV or PWR internals integrity, give us a call. We are eager to help!

Risk Informed Appendix G Evaluations

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ASME Code, Section XI, Appendix G provides a deterministic procedure for defining Service Level A and B P-T limits for ferritic components in the reactor coolant pressure boundary. Under EPRI funding, a team led by Sartrex Corporation, ATI Consulting, and Westinghouse, has developed an alternative risk-informed methodology for Appendix G. SI provided consultation and input to ATI Consulting for the BWR aspects of the work. The alternative methodology provides easy-to-use procedures to define risk-informed pressure-temperature limits for Service Level A and B events, including leak testing and reactor start-up and shut-down conditions. These risk-informed pressure-temperature limits will provide more operational flexibility, particularly for RPVs with relatively high irradiation levels and radiation sensitive materials.

The work under the EPRI project evaluated selected plants spanning the population of PWRs and BWRs. The evaluation included determining appropriate material properties, reviewing operating history and system operational constraints, and performing probabilistic fracture mechanics analyses. The analysis results were used to define risk-informed pressure-temperature relationships that comply with safety goals defined by the NRC, and use consistent inputs and methodology used by the NRC in their re-evaluation of Pressurized Thermal Shock (PTS) regulations. This alternative methodology will provide greater operational flexibility, especially for Service Level A and B events that may adversely affect efficient and safe plant operation, such as low-temperature over-pressurization (LTOP) for PWRs and system leak testing for BWRs. Overall, application of this methodology can result in increased plant efficiency and increased plant and personnel safety.

A Code Change Action has been drafted that recommends new Paragraph G-2216, Risk-Informed Allowable Pressure, and new Paragraph G-2500, Risk-Informed Hydrostatic Leak Testing, be added to Section XI, Appendix G to provide an alternative risk-informed methodology to compute allowable pressure (ksi) as a function of coolant inlet temperature. The existing, deterministic portion of Appendix G will remain unchanged, so that utilities can have the flexibility to continue using existing methods, or a combination of both methods. The Code Change Action was approved by the Working Group on Operating Plant Criteria at the May ASME Code meetings in San Diego. It is hoped that the Code Change will be approved by the end of this year, with publication to follow in the 2010 Edition of the Code.

PWR RPV and Internals Integrity

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SI can provide neutron embrittlement evaluations, such as revised pressure-temperature (P-T) curves, RT_{NDT} and upper shelf energy (USE) material evaluations and LTOP temperature setpoints for PWRs. Updates to the vessel fluence calculations are required for power uprate, license renewal, or to determine fluences on RPV internals. The revised fluence calculations must be performed using a fluence methodology in accordance with NRC Regulatory Guide 1.190. SI is capable of providing such fluence calculations to utilities through our relationship with TransWare Enterprises Inc. TransWare is on SI's Approved Vendor List (AVL), and we can provide a combined evaluation of both fluence and vessel embrittlement. The TransWare and SI team are currently performing fluence calculations and vessel embrittlement aging projections for a Westinghouse-designed PWR. This will be the first PWR to be evaluated using TransWare's RAMA Code, and it demonstrates the capabilities of the SI and TransWare team to evaluate more than just BWR vessel issues.

SI is also actively involved with the EPRI MRP program for managing aging effects in reactor vessel internals. EPRI recently published the Inspection & Evaluation (I&E) Guidelines for Vessel Internals (MRP-227) that will become the industry standard for all PWRs. Under the NEI 03-08 Materials Initiative, it is "Mandatory" that each U.S. PWR develop and document a PWR internals aging management program (AMP) before December 2011. As a part of this aging management program, it is "Needed" that each U.S. PWR implement the tables containing inspection requirements for each applicable vendor design. Earlier implementation of the actions may be required for some plants to meet their plant-specific regulatory commitments for license renewal or power uprate. At least two plants (Ginna and H.B. Robinson 2) are planning to submit their programs this year for NRC review. SI was part of the beta-test team effort for testing the draft I&E Guidelines in 2008, and will continue to be involved with workshops, trainings, and developing templates for use of these guidelines throughout this year. SI can provide assistance or training for developing plant-specific AMPs for vessel internals.

Nozzles in the Beltline - An Update

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As we mentioned in Issue No. 1 of the RPV Integrity Newsletter, a number of plants have recently identified nozzles that meet the definition of being in the beltline region, as defined by the 10CFR50 Appendix H interpretation of the vessel beltline as consisting of all materials for which fluence is projected to exceed 1.0×10^{17} n/cm^2 (E > 1 MeV). Whereas this finding is not new for some plants, other BWRs and PWRs have indicated that the RPV inlet and outlet nozzles may also achieve this threshold when power uprate and/or license renewal fluence levels are considered.

Although this issue was first discovered to be an item to be addressed for license renewal only (i.e., the fluence only became higher than 1.0×10^{17} n/cm^2 when operation beyond 40 years was considered), it has now become a current-day issue for several plants (i.e., the fluence is estimated to be greater than 1.0×10^{17} n/cm^2 at the current point in time). This new discovery can result from a number of reasons, some of which include higher fluence due to power uprate, new fuel designs, and/or improved fluence computing capability and analytical techniques.

As a result of these findings, the following question has now become commonplace: "What is the maximum fluence experienced by the nozzle closest to the core in your RPV?" Utility personnel responsible for the RPV Integrity Program at their plant should be prepared to answer this question as a part of putting together their comprehensive RPV Integrity Programs.

With respect to BWRs, SI's Licensing Topical Report for BWR P-T Curves (see technical note on the next page) addresses forged nozzle configurations in that it provides a fracture mechanics solution for these nozzle designs and requires that all such nozzles be considered as a part of P-T curve development. However, a more recent finding associated with RPV water level instrumentation nozzles is not specifically addressed in SI's Licensing Topical Report for BWR P-T Curves. The "drill-hole" style nozzle configuration of the RPV level instrumentation nozzles is different than traditional forged nozzle designs. A typical configuration is shown in Figure 1. These nozzles have been determined to be located in the beltline plate material where fluence exceeds 1×10^{17} n/cm^2. As a result, the NRC has been providing Requests for Additional Information (RAIs) associated with submittals using SI's Pressure-Temperature Limits Report (PTLR) approach in accordance with the Topical Report.

For these nozzles, as a minimum, the stress concentration effect of the nozzle on the plate material should be addressed as a part of P-T curve development. This can be accomplished with the use of a fracture mechanics model that applies to this nozzle configuration, as shown in Figure 2. In addition, some of the pipe inserts for these nozzles are made of ferritic material, thereby also making them a brittle fracture concern. Such material can be exempted from evaluation under the guidance of G-2223 of Section XI Appendix G for portions of nozzles less than 2.5" thickness, but that exemption still requires that the lowest service temperature not be lower than RT_{NDT} plus 60°F. RT_{NDT} of the pipe insert material may not be available. But, in the evaluation of one BWR-4 plant, SI was able to conservatively estimate the RT_{NDT} for the pipe insert material based on available material records, and show exemption in accordance with G-2223.

SI has successfully performed analysis and shown the RPV level instrument nozzles are bounded by the limiting beltline material P-T curves for one BWR-4 plant (with an austenitic pipe insert), and the NRC has approved the plant's P-T curves for use in a PTLR approach. Evaluation is currently underway for a second BWR-4 plant (with a ferritic pipe insert). Evaluation of a BWR-2 revealed the instrument nozzles to be well outside of the beltline region, thereby allowing the nozzles to be bounded by the (non-beltline) feedwater nozzle.

For all utilities pursuing the PTLR approach in accordance with SI's Licensing Topical Report for BWR P-T Curves, they should be prepared to address this issue as a part of their work to satisfy all requirements and avoid a RAI from the NRC.

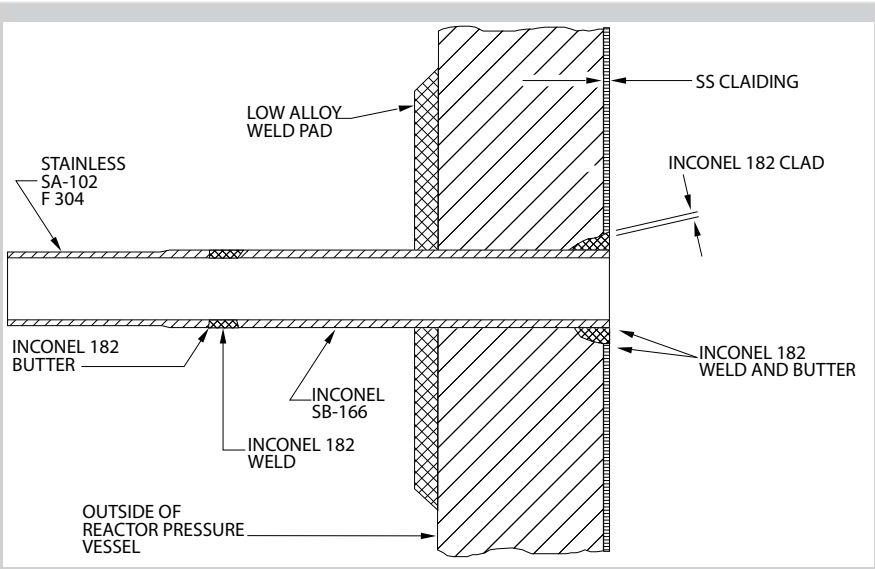

Figure 1: Example of BWR RPV Level Instrumentation Nozzle

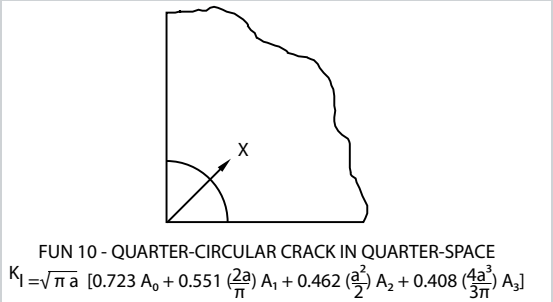

Figure 2: Fracture Mechanics Solution for Instrument Nozzle

Technical Notes:

This section provides brief updates regarding items of interest relevant to RPV Integrity.

Pressure-Temperature Curves

1. Status of SI's Licensing Topical Report for BWR P-T Curves

SI prepared a Licensing Topical Report (LTR) in 2005 under BWR Owners' Group (BWROG) funding; the LTR documents the SI fracture mechanics methods and allows for a "plug and play" approach to RPV P-T curve development and approval. The LTR can be referenced by BWR licensees who co-funded the work and desire to use the SI methodology for their P-T curve development in a license amendment request to adopt NRC Generic Letter (GL) 96-03 requirements for a Pressure-Temperature Limits Report (PTLR). SI received a final Safety Evaluation Review (SER) on the LTR in February 2007. The BWROG transmitted the final "-A" version of the report to the NRC in April 2007. Since submittal of the approved report, two BWRs (a BWR-2 and a BWR-4) have successfully implemented SI's approach for a PTLR, including NRC approval. Approval for both plants was obtained during the Fall of 2008. SI has also developed revised P-T curves using the PTLR approach for three other BWRs (a BWR-2, a BWR-3, and a BWR-4) for future submittal to the NRC. A number of other plant-specific evaluations are about to begin.

2. Preparation of Alternate BWR P-T Curves for Faster Heatup/Cooldown

SI has seen increased interest from utility clients in developing alternate P-T curves enabling heatup/cooldown rates in excess of the 100 °F/Hr rate generally used. Although these higher rate curves are not intended for use during normal operation, the curves enable rapid disposition of small temperature transients that can be experienced and which exceed the 100 °F/Hr rate used for most P-T curves. Having these curves available greatly facilitates performance of a Section XI, Appendix E evaluation on an emergent basis in response to an unanticipated temperature excursion.

Materials Characterization

3. Status of US NRC Regulatory Guide 1.99, Revision 3

This document has not yet been issued. The NRC has not released a schedule for publication; however, issuance of this document is now tied to the NRC issuance of revised 10 CFR 50 Appendices G and H.

4. EPRI BWRVIP Nozzle Forging Report

SI has performed a survey and materials evaluation of the properties of SA508-2 forgings. This evaluation can be used to establish copper and nickel chemistry values for BWR plants that do not have CMTRs or valid data for these forgings. The report was published as BWRVIP-173 and is available through EPRI.

Regulatory Items

5. Status of Revision to 10CFR50 Appendices G & H

The NRC has not released a schedule for issuance of these items.

6. Status of Revision to 10CFR50.61, PTS Rule

The rule is waiting for a vote by the Commission. The NRC has not released a schedule for issuance of this item.

Your Feedback

Please feel free to e-mail us at info@structint.com with your thoughts and input. If you obtained a copy of this newsletter second-hand, and would like to be added to our distribution list, let us know.

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