

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
FINAL SAFETY EVALUATION FOR ELECTRIC POWER RESEARCH INSTITUTE
BOILING WATER REACTOR VESSEL AND INTERNALS PROJECT
TECHNICAL REPORT 1016568, "BWRVIP-18, REVISION 1: BWR CORE SPRAY
INTERNALS INSPECTION AND FLAW EVALUATION GUIDELINES"
PROJECT NO. 704

1.0 INTRODUCTION AND BACKGROUND

By letter dated February 10, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML0904905704), the Boiling Water Reactor (BWR) Vessel Internals Project (BWRVIP) submitted Electric Power Research Institute Technical Report (TR) 1016568, "BWRVIP-18, Revision 1: BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines," which provides generic BWR core spray internals inspection and evaluation guidelines for General Electric (GE) BWR Type 2 (GE BWR/2) through GE BWR Type 6 (GE BWR/6) designs (ADAMS Accession No. ML090490566). This is an update to the previous BWRVIP-18-A report (ADAMS Accession No. ML050910324) which was accepted by the U.S. Nuclear Regulatory Commission (NRC) staff by letter dated September 2, 2005 (ADAMS Accession No. ML052490002). The original BWRVIP-18 was approved by letter dated December 7, 2000 (ADAMS Accession No. ML993430291). The non-editorial revisions included in this latest revision of the TR focused on adding inspection and evaluation considerations for inaccessible welds. The NRC staff requested several clarifications concerning the TR in the request for addition information (RAI) (ADAMS Accession No. ML101540592), and the BWRVIP replied by letters dated March 4, 2011 (ADAMS Accession No. ML110660601).

1.1 Purpose

The NRC staff previously reviewed the BWRVIP-18 and BWRVIP-18-A reports to determine whether they provided an acceptable level of quality for the inspection and reinspection of the subject safety-related reactor pressure vessel internals components. This review focused on reviewing the revised content, specifically the new inaccessible weld inspection and evaluation guidelines. These guidelines included discussion concerning the nature, location, and redundancy of inaccessible welds; methods to determine when inspection of said welds would be necessary, and a method to estimate leakage from any flaws in these welds.

1.2 Organization of this Safety Evaluation

Because only few changes were made in this TR, this safety evaluation (SE) only contains information related to changed and new segments in the TR. This SE contains a brief summary of the TR revisions in Section 1.3, a Regulatory Evaluation in Section 2.0, a Technical Evaluation of these revisions in Section 3.0, and a summary of the staff's conclusions in Section 4.0.

1.3 The following is a summary of BWRVIP-18, Revision 1 revised content:

Executive Summary – The Executive Summary was updated to reflect the various revisions incorporated into the rest of the TR.

TR Section 3 – Numerous additions and revisions were made to cover inaccessible weld inspection and evaluation guidelines as well as to clarify older text. Editorial text was added throughout TR Section 3 addressing the new inaccessible weld text, and several non-related editorial clarifications were made. Tables were updated to include inaccessible welds and the new guidelines for such. Finally, an entire section, TR Section 3.4, was added covering the “Inspection Program for Inaccessible Welds.”

TR Section 5 – Section 5 was updated to include a method to estimate the leakage rate from cracks in inaccessible welds, a table of relevant inaccessible welds for which leakage calculations should or should not be calculated, and two example calculations.

TR Section 6 – The References Section was updated to include new references.

Appendix D – The NRC SE for BWRVIP-18, Rev. 0 was added as Appendix D.

Appendix F – The Record of Revisions from BWRIP-18-A was added as Appendix F.

Appendix G – The NRC acceptance letter for BWRVIP-18-A was added as Appendix G.

Appendix H – A new Record of Revisions was added for the changes made in the TR from BWRVIP-18-A.

2.0 REGULATORY EVALUATION

The BWRVIP guidance regarding core spray internals inspections is a voluntary program pursued by industry in order to address aging management issues in BWR units. At a high level, the general design criteria of Title 10 of the *Code of Federal Regulations* Part 50 Appendix A, “General Design Criteria for Nuclear Power Plants,” apply. Pertinently, Criteria 36 states that “the emergency core cooling system shall be designed to permit appropriate periodic inspection,” with BWRVIP-18 providing details regarding the inspection of the core spray internals portion of such a system. The creation of BWRVIP was, at least in part, motivated by a desire to demonstrate that no increased specificity in NRC regulation for BWR internals aging management would be necessary.

3.0 TECHNICAL EVALUATION

The NRC staff technical evaluation has been split into two sections. Section 3.1 addresses what the staff considers the editorial revisions made in the TR. Section 3.2 addresses the new inaccessible weld program.

3.1 Editorial Revisions

The editorial revisions include text addition to the Executive Summary for currency, the addition of TR Section 1.3, the clarification of several definitions in TR Section 3.1.2, a minor revision in TR Table 3-3, a clarification in TR Section 3.2.4, and the addition and revision of several Appendices containing reference materials and NRC SEs. The NRC staff has reviewed these revisions and finds them acceptable due to their essentially editorial nature.

Two semi-editorial changes were made to TR Section 3.3. First, it was clarified that the rotating sample of the S3 family of welds that attach the spray nozzles to the sparger, lock the threaded joint in the nozzle assembly, or are found in the drain plug on the lower sparger, must achieve [] The NRC staff considers this a sound clarification from the original language that required that [] as this clarification is technically conservative. Secondly, language was added to Section 3.3 noting the existence of inaccessible welds and referring the reader to TR Section 3.4. The NRC staff finds this to be an appropriate addition as there were originally no provisions for reinspection of inaccessible welds and this addition is implied via the addition of new text detailing inspection guidelines concerning inaccessible welds.

3.2 Inaccessible Welds

An inspection program for inaccessible welds was added based on text from Sections 8 and 9 of BWRVIP-168, "BWR Vessels and Internals Project – Guidelines for Disposition of Inaccessible Core Spray Piping Welds in BWR Internals," originally submitted to the NRC for review by letter dated May 30, 2007 (ADAMS Accession No. ML071510546). This program is detailed in TR Sections 3.2.4, 3.4, 5.1.4; and TR Tables 3-6 and 5-1.

The TR lists the P4a, P9, and thermal sleeve welds in GE BWR/2 designs; the P1, P9, and thermal sleeve welds in GE BWR/3-5 designs; and P1a, P1b, and P9 welds in GE BWR/6 designs as being potentially inaccessible welds. With the exception of P9 welds for which there exists full and inspectable structural redundancy, an inspection guideline was established.

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The NRC staff considers that using representative accessible welds as an indicator of the condition of inaccessible welds is appropriate as there are considerably more accessible than inaccessible welds of each type and the degradation of the total population of welds is likely to be self-similar. The NRC staff inquired whether any situations exist where the similar accessible weld was made of less susceptible 304L stainless steel material, while the inaccessible weld was made of 304 stainless steel. [

] The NRC staff considers this response sufficient to alleviate the staff concern.

The NRC staff also questioned the conservatism of a [] criterion for the integrity assessment of the inaccessible welds. In responding to the staff's RAI inquiry, the BWRVIP stated in its RAI response:

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The NRC staff's concern in questioning the [] criterion was based on the need to examine the conservatism in the BWRVIP approach. The RAI response makes clear that a [

] Additionally, as the most threatened components are inspected the most frequently, and any cracking in those components automatically enlarges the inspection scope, it is likely the [] criterion will be reached very quickly if degradation is wide-spread in the subject system. Reassuringly, IGSCC cracks are known to grow quite slowly, providing extra margin on top of the above by increasing the span during which a cracked component still meets minimum structural tolerances.

In light of these arguments, the staff concurs that with a [] criterion, the likelihood that the core spray system operability will be at risk prior to reaching the [] criterion, and for a period after reaching this threshold, is acceptably low. This NRC staff confidence stems from the factors described above, particularly the slow growth rate of IGSCC cracks and hence appreciable time margin afforded for inspections between reaching the assessment criterion and likely consequences.

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] The NRC staff considers this an adequately conservative position that will ensure operation with adequate margin due to the slow growth of IGSCC cracks and the robust conservatism in system design.

Finally, TR Section 5.1.4 was amended to include a methodology extension for calculating leak rates from cracks in inaccessible welds. Following this method creates a distribution of calculated leak rates in the similar accessible welds and then conservatively samples this distribution based on a predicted number of leaking inaccessible welds. [

] The NRC staff concludes that this provides a reasonable method to estimate the leakage through the inaccessible welds, particularly as these are a minority of the total weld population.

In summation, the NRC staff concludes that the additional guidance added to the TR regarding inaccessible welds is technically sound and provides a sufficiently conservative and quality method of controlling for cracking in the subject welds.

4.0 CONCLUSION

The NRC staff has reviewed the TR and the supplemental information that was submitted to the staff by the RAI letter dated March 4, 2011. The NRC staff finds that the revised TR provides an acceptable technical justification with respect to the inspection and flaw evaluation guidelines for BWR core spray internals, specifically those components deemed inaccessible. All other changes were editorial or functionally so in nature and the staff finds those acceptable as well. The TR is considered by the staff to be acceptable for licensing usage.

Principle Contributor: D. Widrevitz

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