

XI.M8 BWR PENETRATIONS

Program Description

The program for boiling water reactor (BWR) vessel instrumentation penetrations, control rod drive (CRD) housing and incore-monitoring housing (ICMH) penetrations and standby liquid control (SLC) nozzles/Core ΔP nozzles includes inspection and flaw evaluation in conformance with the guidelines of staff-approved boiling water reactor vessel and internals project (BWRVIP) Topical Reports BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A. The inspection and evaluation guidelines of BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A contain generic guidelines intended to present appropriate inspection recommendations to assure safety function integrity. The guidelines of BWRVIP-49-A provide information on the type of instrument penetration, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-47-A provide information on components located in the lower plenum region of BWRs, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-27-A are applicable to plants in which the SLC system injects sodium pentaborate into the bottom head region of the vessel (in most plants, as a pipe within a pipe of the core plate ΔP monitoring system). The BWRVIP-27-A guidelines address the region where the ΔP and SLC nozzle or housing penetrates the vessel bottom head and include the safe ends welded to the nozzle or housing. Guidelines for repair design criteria are provided in BWRVIP-57-A for instrumentation penetrations and BWRVIP-53-A for SLC line.

Although this is a condition monitoring program, control of water chemistry helps prevent stress corrosion cracking (SCC) and intergranular stress corrosion cracking (IGSCC). The water chemistry program for BWRs relies on monitoring and control of reactor water chemistry based on industry guidelines, such as BWRVIP-190 (Electric Power Research Institute [EPRI] 1016579) or later revisions. BWRVIP-190 has three sets of guidelines: one for primary water, one for condensate and feedwater, and one for control rod drive (CRD) mechanism cooling water. Adequate aging management activities for these components provide reasonable assurance that the long-term integrity and safe operation of BWR vessel instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations and SLC nozzles/Core ΔP nozzles.

Evaluation and Technical Basis

1. **Scope of Program:** The scope of this program is applicable to BWR instrumentation penetrations, CRD housing and incore-monitoring housing (ICMH) penetrations and BWR SLC nozzles/Core ΔP nozzles. The program manages cracking due to cyclic loading or SCC and IGSCC using inspection and flaw evaluation in accordance with the guidelines of staff-approved BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A.
2. **Preventive Actions:** This program is a condition monitoring program and has no preventive actions. However, maintaining high water purity reduces susceptibility to SCC or IGSCC. The program description, evaluation and technical basis of water chemistry are presented in GALL AMP XI.M2, "Water Chemistry."
3. **Parameters Monitored/Inspected:** The program manages the effects of cracking due to SCC/IGSCC on the intended function of the BWR instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations, and BWR SLC nozzles/Core ΔP nozzles. The program accomplishes this by inspection for cracks in accordance with the

guidelines of approved BWRVIP-49-A, BWRVIP-47-A or BWRVIP-27-A and the requirements of the ASME Code, Section XI, Table IWB 2500-1 (2004 edition⁸).

4. **Detection of Aging Effects:** The evaluation guidelines of BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A provide that the existing inspection requirements in ASME Code, Section XI, Table IWB-2500-1, are sufficient to monitor for indications of cracking in BWR instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations and BWR SLC nozzles/Core ΔP nozzles, and should continue to be followed for the period of extended operation. The extent and schedule of the inspection and test techniques prescribed by the ASME Code, Section XI program are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function of the component.

Instrument penetrations, CRD housing and incore-monitoring housing (ICMH) penetrations and SLC system nozzles or housings are inspected in accordance with the requirements in the ASME Code, Section XI. These examination categories include volumetric examination methods (ultrasonic testing or radiography testing), surface examination methods (liquid penetrant testing or magnetic particle testing), and VT-2 visual examination methods.

5. **Monitoring and Trending:** Inspections scheduled in accordance with ASME Code, Section XI, IWB-2400 and approved BWRVIP-49-A, BWRVIP-47-A, or BWRVIP-27-A provides timely detection of cracks. The scope of examination and reinspection is expanded beyond the baseline inspection if flaws are detected. Any indication detected is evaluated in accordance with ASME Code, Section XI or other acceptable flaw evaluation criteria, such as the staff-approved BWRVIP-49-A, BWRVIP-47-A, or BWRVIP-27-A guidelines. Applicable and approved BWRVIP-14-A, BWRVIP-59-A, and BWRVIP-60-A documents provide additional guidelines for the evaluation of crack growth in stainless steels (SSs), nickel alloys, and low-alloy steels, respectively.
6. **Acceptance Criteria:** Acceptance criteria are given in BWRVIP-49-A for instrumentation nozzles, BWRVIP-47-A for CRD housing and incore-monitoring housing (ICMH) penetrations, and BWRVIP-27A for BWR SLC nozzles/Core ΔP nozzles.
7. **Corrective Actions:** Repair and replacement procedures in staff-approved BWRVIP-57-A and BWRVIP-53-A are equivalent to those required in ASME Code, Section XI. Guidelines for repair design criteria are provided in BWRVIP-57-A for instrumentation penetrations and BWRVIP-53-A for SLC line. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in BWRVIP-49-A, BWRVIP-47-A, and BWRVIP-27-A provides an acceptable level of quality in accordance with 10 CFR Part 50, Appendix B corrective actions. However, any repair in accordance with ASME Code is acceptable.
8. **Confirmation Process:** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in BWRVIP-49-A, BWRVIP-47-A, and BWRVIP-27A, as modified, provides an acceptable level of quality for inspection and flaw evaluation of the safety-related components addressed in accordance with the 10 CFR Part 50, Appendix B confirmation process and administrative controls.

⁸ Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

9. **Administrative Controls:** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.
10. **Operating Experience:** Cracking due to SCC or IGSCC has occurred in BWR components made of austenitic SSs and nickel alloys. The program guidelines are based on an evaluation of available information, including BWR inspection data and information about the elements that cause IGSCC, to determine which locations may be susceptible to cracking. Implementation of the program provides reasonable assurance that cracking will be adequately managed so the intended functions of the instrument penetrations and SLC system nozzles or housings will be maintained consistent with the current licensing basis for the period of extended operation.

References

- 10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.
- 10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.
- ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.
- BWRVIP-14-A (EPRI 1016569), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2008.
- BWRVIP-27-A (EPRI 1007279), *BWR Vessel and Internals Project, BWR Standby Liquid Control System/Core Plate ΔP Inspection and Flaw Evaluation Guidelines*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, August 2003.
- BWRVIP-47-A (EPRI 1009947), *BWR Vessel and Internals Project, BWR Lower Plenum Inspection and Flaw Evaluation Guidelines*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, November 2004.
- BWRVIP-49-A (EPRI 1006602), *BWR Vessel and Internals Project, Instrument Penetration Inspection and Flaw Evaluation Guidelines*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation.
- BWRVIP-53-A (EPRI 1012120), *BWR Vessel and Internals Project, Standby Liquid Control Line Repair Design Criteria Final Safety Evaluation Report* by the Office of Nuclear Reactor Regulation, September 2005.
- BWRVIP-57-A (EPRI 1012111), *BWR Vessel and Internals Project, Instrument Penetration Repair Design Criteria*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2005.

BWRVIP-59-A (EPRI 1014874), BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Nickel-Base Austenitic Alloys in RPV Internals, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, May 2007.

BWRVIP-60-A (EPRI 1008871), BWR Vessel and Internals Project, Evaluation of Stress Corrosion Crack Growth in Low Alloy Steel Vessel Materials in the BWR Environment, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, June 2003.

BWRVIP-190 (EPRI 1016579), BWR Vessel and Internals Project, BWR Water Chemistry Guidelines-2008 Revision, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, October 2008.