XI.M10 BORIC ACID CORROSION

Program Description

The program relies in part on implementation of recommendations in Nuclear Regulatory Commission (NRC) Generic Letter (GL) 88-05 to monitor the condition of the reactor coolant pressure boundary for borated water leakage. Periodic visual inspection of adjacent structures, components, and supports for evidence of leakage and corrosion is an element of the NRC GL 88-05 monitoring program. Potential improvements to boric acid corrosion programs have been identified because of recent operating experience with cracking of certain nickel alloy pressure boundary components (NRC Regulatory Issue Summary 2003-013).

Borated water leakage from piping and components that are outside the scope of the program established in response to NRC GL 88-05 may affect structures and components that are subject to aging management review (AMR). Therefore, the scope of the monitoring and inspections of this program includes all components that contain borated water and that are in proximity to structures and components that are subject to AMR. The scope of the evaluations, assessments, and corrective actions include all observed leakage sources and the affected structures and components.

Borated water leakage may be discovered through activities other than those established specifically to detect such leakage. Therefore, the program includes provisions for triggering evaluations and assessments when leakage is discovered by other activities. The effects of boric acid corrosion on reactor coolant pressure boundary materials in the vicinity of nickel alloy components are managed by GALL AMP XI.M11B, “Cracking of Nickel-Alloy Components and Loss of Material Due to Boric Acid-induced Corrosion in Reactor Coolant Pressure Boundary Components.”

Evaluation and Technical Basis

1. ***Scope of Program:*** The program covers any structures or components on which boric acid corrosion may occur (e.g., steel, copper alloy $>$15% zinc, and aluminum) and electrical components onto which borated reactor water may leak. The program includes provisions in response to the recommendations of NRC GL 88-05. NRC GL 88-05 provides a program consisting of systematic measures to ensure that corrosion caused by leaking borated coolant does not lead to degradation of the leakage source or adjacent structures and components, and provides assurance that the reactor coolant pressure boundary will have an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture. Such a program provides for (a) determination of the principal location of leakage, (b) examinations and procedures for locating small leaks, and (c) engineering evaluations and corrective actions to ensure that boric acid corrosion does not lead to degradation of the leakage source or adjacent structures or components, which could cause the loss of intended function of the structures or components.

2. ***Preventive Actions:*** This program is a condition monitoring program; thus, there are no preventive actions. However, minimizing reactor coolant leakage by frequent monitoring of the locations where potential leakage could occur and timely repair if leakage is detected prevents or mitigates boric acid corrosion.

3. ***Parameters Monitored/Inspected:*** The aging management program monitors the aging effects of loss of material due to boric acid corrosion on the intended function of an affected

structure and component by detection of borated water leakage. Borated water leakage results in deposits of white boric acid crystals and the presence of moisture that can be observed by visual examination. Boric acid deposits, borated water leakage, or the presence of moisture that could lead to the identification of loss of material can be monitored through visual examination.

4. ***Detection of Aging Effects:*** Degradation of the component due to boric acid corrosion cannot occur without leakage of borated water. Conditions leading to boric acid corrosion, such as crystal buildup and evidence of moisture, are readily detectable by visual inspection, though removal of insulation may be required in some cases. However, for leakage examinations of components with external insulation surfaces and joints under insulation or not visible for direct visual examination, the surrounding area (including the floor, equipment surfaces, and other areas where leakage may be channeled) is examined for evidence of component leakage. Discoloration, staining, boric acid residue, and other evidence of leakage on insulation surfaces and the surrounding area are given particular consideration as evidence of component leakage. If evidence of leakage is found, removal of insulation to determine the exact source may be required. The program delineated in NRC GL 88-05 includes guidelines for locating small leaks, conducting examinations, and performing engineering evaluations. In addition, the program includes appropriate interfaces with other site programs and activities, such that borated water leakage that is encountered by means other than the monitoring and trending established by this program is evaluated and corrected. Thus, the use of the NRC GL 88-05 program assures detection of leakage before the loss of the intended function of the affected components.

5. ***Monitoring and Trending:*** The program provides monitoring and trending activities as delineated in NRC GL 88-05, timely evaluation of evidence of borated water leakage identified by other means, and timely detection of leakage by observing boric acid crystals during normal plant walkdowns and maintenance.

6. ***Acceptance Criteria*****:** Any detected borated water leakage, white or discolored crystal buildup, or rust-colored deposits are evaluated to confirm or restore the intended functions of affected structures and components consistent with the design basis prior to continued service.

7. ***Corrective Actions*****:** The NRC finds that the requirements of 10 CFR Part 50, Appendix B, with additional consideration of the guidance in NRC GL 88-05, are acceptable to implement the corrective actions related to this program. Borated water leakage and areas of resulting boric acid corrosion are evaluated and corrected in accordance with the applicable provisions of NRC GL 88-05 and the corrective action program. Any detected boric acid crystal buildup or deposits should be cleaned. NRC GL 88-05 recommends that corrective actions to prevent recurrences of degradation caused by borated water leakage be included in the program implementation. These corrective actions include any modifications to be introduced in the present design or operating procedures of the plant that (a) reduce the probability of primary coolant leaks at locations where they may cause corrosion damage and (b) entail the use of suitable corrosion resistant materials or the application of protective coatings or claddings.

8. ***Confirmation Process:*** Site quality assurance (QA) 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 the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.

9. ***Administrative Controls:*** The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.

10. ***Operating Experience:*** Boric acid corrosion has been observed in nuclear power plants (NRC Information Notice [IN] 86-108 [and supplements 1 through 3] and NRC IN 2003-02) and has resulted in significant impairment of component-intended functions in areas that are difficult to access/observe (NRC Bulletin 2002-01).

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.

NRC Generic Letter 88-05, *Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants*, U.S. Nuclear Regulatory Commission, March 17, 1988.

NRC Information Notice 86-108, *Degradation of Reactor Coolant System Pressure Boundary Resulting from Boric Acid Corrosion*, U.S. Nuclear Regulatory Commission, December 26, 1986; Supplement 1, April 20, 1987; Supplement 2, November 19, 1987; and Supplement 3, January 5, 1995.

NRC Bulletin 2002-01, *Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity,* U.S. Nuclear Regulatory Commission, March 18, 2002.

NRC Bulletin 2002-02, *Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs,* U.S. Nuclear Regulatory Commission, August 9, 2002.

NRC Information Notice 2002-11, *Recent Experience with Degradation of Reactor Pressure Vessel Head,* U.S. Nuclear Regulatory Commission, March 12, 2002.

NRC Information Notice 2002-13, *Possible Indicators of Ongoing Reactor Pressure Vessel Head Degradation,* U.S. Nuclear Regulatory Commission, April 4, 2002.

NRC Information Notice 2003-02, *Recent Experience with Reactor Coolant System Leakage and Boric Acid Corrosion,* U.S. Nuclear Regulatory Commission, January 16, 2003.

NRC Regulatory Issue Summary 2003-013, *NRC Review of Responses to Bulletin 2002-01, 'Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity,'* U.S. Nuclear Regulatory Commission, July 29, 2003.

NUREG-1823, *U.S. Plant Experience with Alloy 600 Cracking and Boric Acid Corrosion of Light-Water Reactor Pressure Vessel Materials*, U.S. Nuclear Regulatory Commission, April 2005.