## AMP 110 PWR Boric Acid Corrosion (Version 2018)

**Programme Description**

The programme monitors the condition of the reactor coolant pressure boundary for sources of borated water leakage. Periodic visual inspections of adjacent structures, components, and supports for evidence of leakage and corrosion are the basis of this monitoring programme.

The scope of the monitoring and inspections of this programme includes all components that contain borated water and that are thus potential leakage locations. Structures and components that may be in the leak paths are also included and are subject to ageing management review (AMR). The issue of cracking of nickel-alloy components and consequential loss of material due to boric acid-induced corrosion in susceptible, safety-related components in the vicinity of nickel-alloy reactor coolant pressure boundary components is addressed in AMP 111.

The scope of the evaluations, assessments, and corrective actions includes 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, such as system walk-downs. Therefore, the programme includes provisions for initiating evaluations and assessments when leakage is discovered by other activities.

### Evaluation and Technical Basis

1. ***Scope of ageing management programme based on understanding ageing:***

The programme covers any structures (e.g., galvanized steel, aluminium, steel), components (e.g., steel, copper and aluminium alloy) or electrical components on which boric acid corrosion may be expected to occur after a borated water leak. The programme includes systematic measures to ensure that corrosion caused by leaking borated water 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 leakage, rapidly propagating failure, or gross rupture. Such a programme 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 and components, which could cause the loss of intended function of the structures or components.

1. ***Preventive actions to minimize and control ageing degradation:***

This programme is a condition monitoring programme; thus, there are no preventive actions. However, boric acid corrosion can be prevented or minimized through measures to minimize borated water leakage, such as frequent monitoring of the locations where potential leakage could occur and timely repair if leakage is detected. In addition, the use of suitable corrosion resistant materials or the application of protective coatings or claddings can serve to prevent boric acid corrosion.

1. ***Detection of ageing effects:***

The programme monitors the ageing effects of loss of material due to boric acid corrosion of affected structures and components 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 cause loss of material can be detected and monitored through visual examination.

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 build-up and evidence of moisture, are readily detectable by visual inspection, although removal of insulation may be required in some cases. However, for leakage examinations of components with external insulation surfaces and joints under insulation or components not visible for direct visual examination, the surrounding area (including the floor, equipment surfaces, and other areas where leakage may be channelled) is examined for evidence of component leakage. Potential indications of boric acid leakage include discoloration, staining, and boric acid residue on insulation surfaces and the surrounding area. If evidence of leakage is found, removal of insulation to determine the leakage source may be required. The programme includes guidelines for locating small leaks, conducting examinations, and performing engineering evaluations. In addition, the programme includes appropriate interfaces with other site programmes and activities, such that borated water leakage that is detected by means other than the monitoring and trending established by this programme is evaluated and corrected. Thus, this programme, including the guidance of national documents such as U.S. Nuclear Regulatory Commission Generic Letter 88-05 [1], assures timely detection of leakage before the loss of the intended function of the affected components.

1. ***Monitoring and trending of ageing effects:***

The programme provides monitoring and trending activities through timely detection of leakage by observing boric acid crystals during normal plant walk-downs and maintenance and timely evaluation of evidence of borated water leakage identified by other means.

1. ***Mitigating ageing effects:***

Since boric acid corrosion requires an active leakage of borated water, the programme mitigates boric acid corrosion through the effective and timely identification and remediation of boric acid leakage.

1. ***Acceptance criteria:***

Any detected borated water leakage, white or discoloured crystal build-up, or rust-coloured deposits are evaluated to confirm or restore the intended functions of affected structures and components consistent with the design basis prior to continued service.

1. ***Corrective actions:***

Borated water leakage and areas of resulting boric acid corrosion are evaluated and corrected through the corrective action programme. Any detected boric acid crystal build-up or deposits will be cleaned and the condition of the affected surface(s) is evaluated to determine if repair or replacement is required. Programme implementation includes corrective actions to prevent recurrences of degradation caused by borated water leakage. 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 borated water 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.

1. ***Operating experience feedback and feedback of research and development results:***

This AMP addresses the industry-wide generic experience. Relevant plant-specific operating experience is considered in the development of the plant AMP to ensure the AMP is adequate for the plant. The plant implements a feedback process to periodically evaluate plant and industry-wide operating experience and research and development (R&D) results, and, as necessary, either modifies the plant AMP or takes additional actions (e.g. develop a new plant-specific AMP) to ensure the continued effectiveness of the ageing management.

Numerous instances of boric acid corrosion have been identified. Experience for reactor vessels is provided in the 2007 update of IAEA-TECDOC-1556 [2] and primary piping in IAEA‑TECDOC‑1361 [3].

Although associated with conditions which are managed by AMP 111 the most significant observation in the USA is described in US NRC Information Notice (IN) 2002-11 [4]. Additional information on observed degradation can be found in several documents ([1, 5-9]. Additional information on managing boric acid corrosion issues at PWR power stations is provided in industry guidance [10].

At the time when this AMP was produced, no relevant R&D was identified.

1. ***Quality management:***

Site quality assurance procedures, review and approval processes, and administrative controls will be implemented, consistent with national requirements in accordance with different national regulatory requirements (e.g., 10 CFR Part 50, Appendix, B [11]).

### References

[1] UNITED STATES NULEAR REGULATORY COMMISSION, NRC Generic Letter 88-05, Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants, USNRC, Washington, D.C., March 17, 1988

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: PWR Pressure Vessels (2007 Update), IAEA-TECDOC-1556, IAEA, Vienna, June 2007

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: Primary Piping in PWRs, IAEA-TECDOC-1361, IAEA, Vienna, July 2003

[4] UNITED STATES NULEAR REGULATORY COMMISSION, NRC Information Notice 2002-11, Recent Experience with Degradation of Reactor Pressure Vessel Head, USNRC, Washington, D.C., March 12, 2002

[5] UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Information Notice 86‑108, Degradation of Reactor Coolant System Pressure Boundary Resulting from Boric Acid Corrosion*,* December 26, 1986; Supplement 1, April 20, 1987; Supplement 2, November 19, 1987; and Supplement 3, USNRC, Washington, D.C., January 5, 1995

[6] UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Bulletin 2002-01, Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity, USNRC, Washington, D.C., March 18, 2002

[7] UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Information Notice 2003-02, Recent Experience with Reactor Coolant System Leakage and Boric Acid Corrosion, USNRC, Washington, D.C., January 16, 2003

[8] UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Regulatory Issue Summary 2003-13, NRC Review of Responses to Bulletin 2002-01, “Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity,” USNRC, Washington, D.C., July 29, 2003

[9] UNITED STATES NUCLEAR REGULATORY COMMISSION, NUREG-1823, U.S. Plant Experience with Alloy 600 Cracking and Boric Acid Corrosion of Light-Water Reactor Pressure Vessel Materials, USNRC, Washington, D.C., April 2005

[10] ELECTRIC POWER RESEARCH INSTITUTE; Boric Acid Corrosion Guidebook, Revision 2: Managing Boric Acid Corrosion Issues at PWR Power Stations (MRP-058, Rev 2). EPRI, Palo Alto, CA: 2012. 1025145

[11] UNITED STATES NUCLEAR REGULATORY COMMISSION, 10 CFR Part 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants, Office of the Federal Register, National Archives and Records Administration, Latest Edition