## AMP 117 Closed Treated WATER SYSTEMS (VERSION 2021)

### Programme Description

Nuclear power plants contain many closed, chemically treated water systems. These systems undergo water treatment to control water chemistry and prevent corrosion (i.e., treated water systems). These systems are also recirculating systems in which the rate of recirculation is much higher than the rate of addition of makeup water (i.e., closed systems). The programme includes (a) water treatment, including the use of corrosion inhibitors, to modify the chemical composition of the water such that the function of the equipment is maintained and such that the effects of corrosion are minimized; (b) chemical testing of the water to ensure that the water treatment programme maintains the water chemistry within acceptable guidelines; and (c) inspections to determine the presence or extent of corrosion, cracking, and fouling. Depending on the industry standard selected for use in association with this AMP and/or plant operating experience, this programme also may include corrosion monitoring (e.g., corrosion coupon testing) and microbiological testing.

### Evaluation and Technical Basis

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

This programme manages the ageing effects of reduction of heat transfer due to fouling, loss of material due to corrosion, and cracking due to stress corrosion cracking of the internal surfaces of piping, piping components, and piping elements fabricated from any material and exposed to treated water. Examples of systems managed by this AMP include closed-cycle cooling water systems (systems not subject to significant sources of contamination, in which water chemistry is controlled, heat is not directly rejected to an ultimate heat sink, and the system is not open to the environment, such as open cooling systems); closed portions of heating, ventilation, and air conditioning systems; diesel generator cooling water; and auxiliary boiler systems [1, 2]. Examples of systems not addressed by this AMP include boiling water reactor (BWR) coolant, pressurized water reactor (PWR) primary and secondary water, PWR/BWR condensate systems. Ageing in these systems is managed by the AMP103 ‘Water Chemistry’ and AMP102 ‘In-service Inspection/Periodic inspection’. Treated fire water systems, if present, are also not included in this AMP. The water used in systems covered by this AMP may, but need not, be demineralized. The water used in systems covered by this AMP receives chemical treatment, including corrosion inhibitors. Untreated water systems are addressed using other AMPs, such as AMP135, ‘Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components’.

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

This programme uses water treatment to mitigate the ageing effects of loss of material due to corrosion, cracking due to stress corrosion cracking, and reduction of heat transfer due to fouling from corrosion products or biological activity. The water treatment programme includes corrosion inhibitors and is designed to maintain the function of associated equipment and minimize the water corrosivity and biological activity.

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

This programme monitors water chemistry (preventive monitoring) and the visual appearance of surfaces exposed to the water (condition monitoring). Depending on the industry standard selected for use in association with this AMP and/or plant operating experience, this programme may also include corrosion monitoring (e.g., corrosion coupon testing) and microbiological testing.

Water chemistry parameters (such as the concentration of iron, copper, silica, oxygen; and hardness, alkalinity, specific conductivity, and pH) are monitored because maintenance of optimal water chemistry prevents loss of material and cracking due to corrosion and stress corrosion cracking. The specific water chemistry parameters monitored and the acceptable range of values for these parameters are in accordance with industry standard guidance documents (e.g., the Electric Power Research Institute (EPRI) Guideline 3002000590 [3], ASTM standards, water chemistry guidelines recommended by the equipment manufacturer or the ASME Nalco). In all cases, the selected industry standard guidance document is used in its entirety for the water chemistry control or guidance. The frequency of water testing is in accordance with the selected industry standard, but in no case the testing interval is greater than quarterly unless justified with an additional analysis.

Because the control of water chemistry may not be fully effective in mitigating the ageing effects, periodic inspections are conducted. The visual appearance of surfaces provides evidence of loss of material. Surface discontinuities revealed by surface or volumetric examination techniques provide evidence of cracking. The heat transfer capability of heat exchanger surfaces is evaluated by either visual inspections to determine surface cleanliness, or functional testing to verify that design heat removal rates are maintained.

Visual inspections of internal surfaces are conducted whenever the system boundary is opened. Additionally, a representative sample of piping and components is selected based on likelihood of corrosion, cracking, and fouling and is inspected at an interval not to exceed once in 10 years. Based on the criteria used in AMP 119 at a minimum, a representative sample of 20 percent of the population (defined as components having the same material, water treatment programme, and ageing effect combination) or a maximum of 25 components per population at each unit is inspected using techniques capable of detecting loss of material, cracking, and fouling, as appropriate. Additional sampling guidance for components is provided in [4].

If degradation is identified in the initial sample, additional samples are inspected to determine the extent of the condition. Technical justification for an alternative sampling methodology is included in the program’s documentation. Inspections are conducted in accordance with applicable code requirements. In the absence of code inspection requirements, inspections are conducted in accordance with the selected industry standard. In the event that the selected industry standard does not contain inspection requirements, plant-specific inspection and personnel qualification procedures that are capable of detecting corrosion, cracking, and fouling may be used. If visual examination identifies adverse conditions, additional examinations, including ultrasonic testing, are conducted. Plant operating experience and/or the industry standard programme selected for use in association with this AMP may recommend corrosion, heat transfer, and/or microbiological testing.

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

Water chemistry data are evaluated against the standards contained in the selected industry standard documents. These data are trended with time, so corrective actions are taken, based on trends in water chemistry, prior to loss of intended function. Inspection results also are trended with time so that the progression of any corrosion or cracking can be evaluated and predicted.

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

This programme mitigates loss of material due to corrosion, cracking due to stress corrosion cracking, and reduction of heat transfer due to fouling from corrosion and biological activity in components exposed to a closed treated water environment. For this reason, the monitoring methods and frequency of water chemistry sampling and testing is performed in accordance with industry standard guidelines.

1. ***Acceptance criteria:***

Water chemistry concentrations are maintained within the limits specified in the selected industry standard documents. System components meet system design requirements, such as minimum component wall thickness or heat transfer capability.

1. ***Corrective actions:***

Water chemistry concentrations that are not in accordance with the selected industry standard document are returned to an “in specification” condition in accordance with the referenced guidelines. Some industry standard documents have time guidelines which govern how rapidly “out of specification” conditions are corrected.

Engineering evaluations are performed for inspection results that do not satisfy established acceptance criteria. Corrective actions are accomplished through the plant’s corrective actions programme to ensure that conditions adverse to quality are promptly corrected. If the deficiency is assessed to be significantly adverse to quality, the cause of the condition is determined and an action plan is developed to preclude repetition. Unacceptable inspection findings result in additional inspection(s) being performed, which may be on a periodic basis, or in component repair or replacement.

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.

Observations of degradation of closed-cycle cooling water systems in the United States include corrosion product buildup (NRC Licensee Event Report [LER] 50-327/93-029-00) [5] and through-wall cracks in supply lines (NRC LER 50-280/91-019-00) [6]. Accordingly, operating experience demonstrates the need for this programme.

In addition, SCC of stainless steel (SS) reactor recirculation pump seal heat exchanger coils has been attributed to localized boiling of the closed cooling water, concentrating water impurities on the coil surfaces (LER 263/2014-001) [7].

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 are implemented in accordance with the different national regulatory requirements (e.g., 10 CFR 50, Appendix B [8]).

### References

1. UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Letter 89-13, Service Water System Problems Affecting Safety-Related Components, USNRC, July 18, 1989.
2. UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Letter 89-13, Supplement 1, Service Water System Problems Affecting Safety-Related Components, USNRC, April 4, 1990.
3. ELECTRIC POWER RESEARCH INSTITUTE, EPRI 3002000590, Closed Cooling Water Chemistry Guideline, Rev. 2, December 2013.
4. UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report — Final Report (NUREG-2191), USNRC, 2017.
5. UNITED STATES NUCLEAR REGULATORY COMMISSION, Licensee Event Report 50-327/93-029-00, Inoperable Check Valve in the Component Cooling System as a Result of a Build-Up of Corrosion Products between Valve Components, USNRC, December 13, 1993.
6. UNITED STATES NUCLEAR REGULATORY COMMISSION, Licensee Event Report 50-280/91-019-00, Loss of Containment Integrity due to Crack in Component Cooling Water Piping, USNRC, October 26, 1991.
7. UNITED STATES NUCLEAR REGULATORY COMMISSION Licensee Event Report 263-2014-001, “Primary System Leakage Found in Recirculation Pump Upper Seal Heat Exchanger.” USNRC, March 2014.
8. 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, USNRC, Latest Edition.