XI.M21A CLOSED TREATED WATER SYSTEMS

Program Description

Nuclear power plants contain many closed, 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 program 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 program maintains the water chemistry within acceptable guidelines; and (c) inspections to determine the presence or extent of corrosion and/or cracking. Depending on the industry standard selected for use in association with this aging management program (AMP) and/or plant operating experience, this program also may include corrosion monitoring (e.g., corrosion coupon testing) and microbiological testing.

Evaluation and Technical Basis

1. ***Scope of Program:*** This program manages the aging effects of reduction of heat transfer due to fouling, or the loss of material from and cracking due to corrosion and/or stress corrosion cracking of the internal surfaces of piping, piping components, and piping elements fabricated from any material and exposed to treated water. Not included are those piping systems that are managed by another AMP. Examples of systems managed by this AMP include closed-cycle cooling water systems (as defined by U.S. Nuclear Regulatory Commission [NRC] Generic Letter [GL] 89-13[14]); closed portions of heating, ventilation, and air conditioning systems; diesel generator cooling water; and auxiliary boiler systems. Examples of systems not addressed by this AMP include boiling water reactor (BWR) coolant, pressurized water reactor (PWR) primary and secondary water, and PWR/BWR condensate systems. Aging in these systems is managed by the water chemistry AMP (XI.M2) and American Society of Mechanical Engineers (ASME) Section XI, Inservice Inspection, Subsections IWB, IWC, and IWD AMP (XI.M1). 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 Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (XI.M38).

2. ***Preventive Actions:*** This program mitigates aging effects of loss of material and cracking that are due to corrosion and stress corrosion cracking through water treatment. The water treatment program includes corrosion inhibitors and is designed to maintain the function of associated equipment and minimize the corrosivity of the water.

3. ***Parameters Monitored/Inspected:*** This program 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

[14] NRC GL 89-13 defines a service water system as "the system or systems that transfer heat from safety-related structures, systems, or components to the ultimate heat sink." NRC GL 89-13 further defines a closed-cycle system as a part of the service water system that is not subject to significant sources of contamination, one in which water chemistry is controlled and in which heat is not directly rejected to an ultimate heat sink.

AMP and/or plant operating experience, this program may also include corrosion monitoring (e.g., corrosion coupon testing) and microbiological testing. These 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. In addition, the visual appearance of surfaces provides evidence of the existence of loss of material or cracking. The specific water chemistry parameters monitored and the acceptable range of values for these parameters are in accordance with industry standard guidance documents produced by the Electric Power Research Institute (EPRI), the American Society of Heating Refrigeration and Air-Conditioning Engineers, the Cooling Technology Institute, the American Boiler Manufacturer's Association, ASTM standards, water chemistry guidelines recommended by the equipment manufacturer, Nalco Water Handbook, or the ASME. For closed-cycle cooling water systems as defined in NRC GL 89-13, EPRI 1007820 is used. For other systems, the applicant selects an appropriate industry standard document. In all cases, the selected industry standard guidance document is used in its entirety for the water chemistry control or guidance.

4. ***Detection of Aging Effects:*** In this program, aging effects are detected through water testing and periodic inspections. Water testing ensures that the water treatment program is effective in maintaining acceptable water chemistry. Water testing is conducted in accordance with the selected industry standard. The frequency of water testing is in accordance with the selected industry standard, but in no case should the testing interval be greater than quarterly unless justified with an additional analysis. Because the control of water chemistry may not be fully effective in mitigating the aging effects, visual inspections are conducted. Inspections are conducted whenever the system boundary is opened. Additionally, a representative sample of piping and components is selected based on likelihood of corrosion or cracking and inspected at an interval not to exceed once in 10 years. When required by the ASME Code, inspections are conducted in accordance with the 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 or cracking may be used. If visual examination identifies adverse conditions, additional examinations, including ultrasonic testing, are conducted. Plant operating experience and/or the industry standard program selected for use in association with this AMP may recommend corrosion testing and/or microbiological testing. If warranted, these tests are conducted in accordance with the industry standard selected or other industry standards appropriate for the conduct of corrosion or microbiological testing.

5. ***Monitoring and Trending:*** 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.

6. ***Acceptance Criteria:*** Water chemistry concentrations are maintained within the limits specified in the selected industry standard documents. System components should meet system design requirements, such as minimum wall thickness.

7. ***Corrective Actions:*** Water chemistry concentrations that are not in accordance with the selected industry standard document should be 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 should be corrected. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address corrective actions.

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 the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.

9. ***Administrative Controls:*** As discussed in the Generic Aging Lessons Learned (GALL) Report, the staff finds the requirements 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** Degradation of closed-cycle cooling water systems due to corrosion product buildup (NRC Licensee Event Report [LER] 50-327/93-029-00) or through-wall cracks in supply lines (NRC LER 50-280/91-019-00) has been observed in operating plants. Accordingly, operating experience demonstrates the need for this program.

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.

EPRI 1007820, *Closed Cooling Water Chemistry Guideline*, Electric Power Research Institute, Palo Alto, CA, April 2004.

Flynn, Daniel. *The Nalco Water Handbook*, Nalco Company, 2009.

NRC Generic Letter 89-13, *Service Water System Problems Affecting Safety-Related Components*, U.S. Nuclear Regulatory Commission, July 18, 1989.

NRC Generic Letter 89-13, Supplement 1, *Service Water System Problems Affecting Safety-Related Components*, U.S. Nuclear Regulatory Commission, April 4, 1990.

NRC Licensee Event Report 50-280/91-019-00, *Loss of Containment Integrity due to Crack in Component Cooling Water Piping*, October 26, 1991.

NRC 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*, December 13, 1993.