XI.M20 OPEN-CYCLE COOLING WATER SYSTEM

Program Description

The program relies on implementation of the recommendations of the Nuclear Regulatory Commission (NRC) Generic Letter (GL) 89-13 to ensure that the effects of aging on the open-cycle cooling water (OCCW) (or service water) system will be managed for the period of extended operation. NRC GL 89-13 defines the OCCW system as a system or systems that transfer heat from safety-related structures, systems, and components (SSCs) to the ultimate heat sink (UHS). The guidelines of NRC GL 89-13 for managing an OCCW include (a) surveillance and control of biofouling (see Chapter IX of NUREG-1801); (b) a test program to verify heat transfer capabilities; (c) routine inspection and a maintenance program to ensure that corrosion, erosion, protective coating failure, sediment deposition (silting), and biofouling cannot degrade the performance of safety-related systems serviced by OCCW; (d) a system walkdown inspection to ensure compliance with the licensing basis; and (e) a review of maintenance, operating, and training practices and procedures.

In accordance with guidance of NRC GL 89-13, the OCCW aging management program manages aging effects of components in raw water systems, such as the service water or river water, by using a combination of preventive, condition, and performance monitoring activities. These include (a) surveillance and control techniques to manage aging effects caused by biofouling, corrosion, erosion, protective coating failures, and silting in the OCCW system or structures and components serviced by the OCCW system; (b) inspection of critical components for signs of corrosion, erosion, and biofouling; and (c) testing of the heat transfer capability of heat exchangers that remove heat from components important to safety.

For buried OCCW piping, the aging effects on the external surfaces are managed by XI.M41, but the internal surfaces are managed by this program. The aging management of closed-cycle cooling water (CCCW) systems is described in XI.M21A, “Closed Treated Water Systems,” and is not included as part of this program. The OCCW System program applies to components constructed of various materials, including steel, stainless steel, aluminum, copper alloys, titanium, polymeric materials, and concrete. Piping may be lined with internal coatings or unlined.

Evaluation and Technical Basis

1. ***Scope of Program:*** The program addresses the aging effects of material loss and fouling due to micro- or macro-organisms and various corrosion mechanisms generally found in OCCW systems and OCCW steel piping components with or without protective coating as described in the applicant’s response to NRC GL 89-13. OCCW systems, as defined by NRC GL 89-13, include the service water system and any other cooling system exposed to raw water that transfers heat from safety-related SSCs to the UHS. The OCCW System program applies to components constructed of various materials, including steel, stainless steel, aluminum, copper alloys, titanium, polymeric materials, and concrete. Piping may be lined with internal coatings or unlined.

2. ***Preventive Actions:*** Preventive actions begin with the use of appropriate material for construction. Steel piping system components are typically lined or coated to protect the underlying metal surfaces from exposure to corrosive cooling water environments. Implementation of NRC GL 89-13 includes control or preventive measures, such as chemical treatment whenever the potential for biological fouling exists or flushing of

infrequently used systems. Treatment with chemicals mitigates microbiologically-influenced corrosion (MIC) and buildup of macroscopic biological fouling debris from biota, such as blue mussels, oysters, or clams. Periodic flushing of the system removes accumulations of biofouling agents, corrosion products, and debris or silt.

3. ***Parameters Monitored/Inspected:*** This program manages the aging effects, such as loss of heat transfer capability, loss of material, and corrosion effects. Adverse effects on system or component performance are caused by accumulations of biofouling agents, corrosion products, and silt. Cleanliness and material integrity of piping, components, heat exchangers, elastomers, and their internal linings or coatings (when applicable) that are part of the OCCW system or that are cooled by the OCCW system are periodically inspected, monitored, or tested to ensure their heat transfer capabilities. The program ensures (a) removal of accumulations of biofouling agents, corrosion products, and silt and (b) detection of defective protective coatings and corroded OCCW system piping and components that could adversely affect performance of their intended safety functions.

4. ***Detection of Aging Effects:*** Inspection scope, methods (e.g., visual or nondestructive examination), and testing frequencies are in accordance with the applicant's docketed response to NRC GL 89-13. Inspections for biofouling, damaged coatings, and degraded material condition are conducted. Visual inspections are typically performed to determine whether corrosion, erosion, or biofouling are occurring in the system. Examinations of polymeric materials should be consistent with the examinations described in AMP XI.M38. Nondestructive testing, such as ultrasonic testing and eddy current testing, are effective methods to measure surface conditions or the extent of wall thinning associated with the service water system piping and components.

5. ***Monitoring and Trending:*** Heat transfer testing results are documented in plant test procedures and are trended in accordance with the applicant's docketed response to NRC GL 89-13. If corrosion buildup or fouling is noted, the system also is evaluated for their impact on the heat transfer capability of the system. Evidence of corrosion in these systems also is evaluated for its potential impact on the integrity of the piping. For relevant indications, inspections or nondestructive testing is used to determine the extent of biofouling, the condition of the surface coating, the magnitude of localized pitting, and the amount of MIC, if applicable.

6. ***Acceptance Criteria:*** The acceptance criteria are in accordance with the applicant's docketed response to NRC GL 89-13. Corrosion, erosion, and biofouling can cause significant loss of material in components. Inspected components should exhibit adequate design margin regarding design dimensions (e.g., minimum required wall thickness). As applicable, coatings or linings should be intact to protect the underlying metal. Heat removal capability is within allowable values for the system and components tested, in accordance with NRC GL 89-13.

7. ***Corrective Actions:*** Evaluations are performed for test or inspection results that do not satisfy established acceptance criteria, and a problem or condition report is initiated to document the concern in accordance with plant administrative procedures. The corrective actions program ensures that the 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. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the 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 controls.

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:*** Significant MIC (NRC Information Notice [IN] 85-30, IN 07-06), failure of protective coatings (NRC IN 85-24), and fouling (NRC IN 81-21, IN 86-96, IN 07-04, IN 07-28) have been observed in a number of heat exchangers. The guidance of NRC GL 89-13 has been implemented for more than 20 years and has been effective in managing aging effects due to biofouling, corrosion, erosion, protective coating failures, and silting in structures and components serviced by OCCW systems.

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 1016555, *PWR Secondary Water Chemistry Guidelines–Revision 7*, Electric Power Research Institute, Palo Alto, CA, February 2009.

EPRI 1014986, *PWR Primary Water Chemistry Guidelines-Revision* 6*, Volumes 1 and 2*, Electric Power Research Institute, Palo Alto, CA, December 2007.

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 Information Notice 81-21, *Potential Loss of Direct Access to Ultimate Heat Sink*, U.S. Nuclear Regulatory Commission, July 21, 1981.

NRC Information Notice 85-24, *Failures of Protective Coatings in Pipes and Heat Exchangers*, U.S. Nuclear Regulatory Commission, March 26, 1985.

NRC Information Notice 85-30, *Microbiologically Induced Corrosion of Containment Service Water System*, U.S. Nuclear Regulatory Commission, April 19, 1985.

NRC Information Notice 86-96, *Heat Exchanger Fouling Can Cause Inadequate Operability of Service Water Systems*, U.S. Nuclear Regulatory Commission, November 20, 1986.

NRC Information Notice 2004-07, *Plugging of Safety Injection Pump Lubrication Oil Coolers With Lakeweed*, U.S. Nuclear Regulatory Commission, April 7, 2004.

NRC Information Notice 2007-28*, Potential Common Cause Vulnerabilities in Essential Service Water Systems Due to Inadequate Chemistry Controls*, U.S. Nuclear Regulatory Commission, September 17, 2007.

NRC Information Notice 2007-06, *Potential Common Cause Vulnerabilities in Essential Service Water Systems*, U.S. Nuclear Regulatory Commission, February 9, 2007.

NUREG-1915, *Safety Evaluation Report Related to the License Renewal of Wolf Creek Generating Station*, U.S. Nuclear Regulatory Commission, October 2008.