XI.M33 SELECTIVE LEACHING

Program Description

This program demonstrates the absence of selective leaching. The program for selective leaching of materials ensures the integrity of the components made of gray cast iron and copper alloys (except for inhibited brass) that contain greater than 15 percent zinc (> 15% Zn) or greater than 8 percent aluminum (>8% Al in the case of aluminum-bronze) exposed to a raw water, closed cooling water, treated water, or ground water environment that may lead to selective leaching of one of the metal components where there has not been previous experience of selective leaching. The AMP includes a one-time visual inspection of selected components that may be susceptible to selective leaching, coupled with either hardness measurements (where feasible, based on form and configuration) or mechanical examination techniques. These techniques can determine whether loss of materials due to selective leaching is occurring and whether selective leaching will affect the ability of the components to perform their intended function for the period of extended operation.

The selective leaching process involves the preferential removal of one of the alloying elements from the material, which leads to the enrichment of the remaining alloying elements. Dezincification (loss of zinc from brass) and graphitization (removal of iron from cast iron) are examples of such a process. Susceptible materials, high temperatures, stagnant-flow conditions, and a corrosive environment, such as acidic solutions for brasses with high zinc content and dissolved oxygen, are conducive to selective leaching.

Although the program does not provide guidance on preventive action, it is noted that monitoring of water chemistry to control pH and concentration of corrosive contaminants and treatment to minimize dissolved oxygen in water are effective in reducing selective leaching. Water chemistry is managed by the Water Chemistry program (AMP XI.M2).

Evaluation and Technical Basis

1. ***Scope of Program:*** This program demonstrates the absence of selective leaching. For materials and environments where selective leaching is currently occurring or for materials in environments where the component has been repaired with the same material, a plant-specific program is required. Components include piping, valve bodies and bonnets, pump casings, and heat exchanger components that are susceptible to selective leaching. The materials of construction for these components may include gray cast iron and uninhibited brass containing greater than 15% zinc. These components may be exposed to raw water, treated water, closed cooling water, ground water, water contaminated fuel oil, or water-contaminated lube oil.

2. ***Preventive Actions:*** This program is a condition monitoring program and it contains no preventive actions.

3. ***Parameters Monitored/Inspected:*** This program monitors selective leaching through the monitoring of surface hardness and visual appearance (color, porosity, abnormal surface conditions).

4. ***Detection of Aging Effects:*** The visual inspection and hardness measurement or other mechanical examination techniques, such as destructive testing (when the opportunity arises), chipping, or scraping, is a one-time inspection conducted within the last 5 years

prior to entering the period of extended operation. Because selective leaching is a slow acting corrosion process, this measurement is performed just prior to the period of extended operation. Follow-up of unacceptable inspection findings includes an evaluation using the corrective action program and a possible expansion of the inspection sample size and location.

Where practical, the inspection includes a representative sample of the system population and focuses on the bounding or lead components most susceptible to aging due to time in service, severity of operating conditions, and lowest design margin. Twenty percent of the population with a maximum sample of 25 constitutes a representative sample size. Otherwise, a technical justification of the methodology and sample size used for selecting components for one-time inspection should be included as part of the program's documentation. Each group of components with different material/environment combinations is considered a separate population.

Selective leaching generally does not cause changes in dimensions and is difficult to detect by visual inspection. However, in certain brasses, it causes plug-type dezincification, which can be detected by visual inspection. One acceptable procedure is to visually inspect the susceptible components closely and conduct Brinell hardness testing (where feasible, based on form and configuration or other industry-accepted mechanical inspection techniques) on the inside surfaces of the selected set of components to determine if selective leaching has occurred. If selective leaching is apparent, an engineering evaluation is initiated to determine acceptability of the affected components for further service.

5. ***Monitoring and Trending:*** This is a one-time inspection to determine if selective leaching is an issue. Monitoring and trending is not required.

6. ***Acceptance Criteria:*** The acceptance criteria are no visible evidence of selective leaching or no more than a 20 percent decrease in hardness. For copper alloys with greater than 15 percent zinc, the criteria is no noticeable change in color from the normal yellow color to the reddish copper color.

7. ***Corrective Actions:*** Engineering evaluations are performed for test or inspection results that do not satisfy established acceptance criteria. The corrective actions program ensures 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. 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. Unacceptable inspection findings result in additional inspection(s) being performed, which may be on a periodic basis, or in component repair or replacement.

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:*** The elements that comprise these inspections (e.g., the scope of the inspections and inspection techniques) are consistent with industry practice and staff expectations. Selective leaching has been detected in components constructed from cast iron, brass, bronze, and aluminum bronze. Components affected have included valve bodies, pump casings, piping, and cast iron fire protection piping buried in soil.

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 TR-107514, *Age Related Degradation Inspection Method and Demonstration*, Electric Power Research Institute, April 1998.

Fontana, M. G., *Corrosion Engineering*, McGraw Hill, p 86-90, 1986.

NUREG-1705, *Safety Evaluation Report Related to the License Renewal of Calvert Cliffs Nuclear Power Plant, Units 1 and 2*, U.S. Nuclear Regulatory Commission, December 1999.

NUREG-1723, *Safety Evaluation Report Related to the License Renewal of Oconee Nuclear Station, Units 1, 2, and 3*, U.S. Nuclear Regulatory Commission, March 2000.

NUREG-1930, *Safety Evaluation Report Related to the License Renewal of Indian Point Nuclear Generating Units 2 and 3*, U.S. Nuclear Regulatory Commission, November 2009.

Schweitzer, P. A., *Encyclopedia of Corrosion Technology 2nd Ed*, Marcel Dekker, p 201-202. March 17, 2004.