PrairieIslandNPEm Resource

From: Eckholt, Gene F. [Gene.Eckholt@xenuclear.com]
Sent: Wednesday, February 11, 2009 5:55 PM
To: Stuart Sheldon
Subject: Selective Leaching Sampling Methodology
Attachments: LR_TR_540 Rev A-- Selective Leaching bindered.pdf

Stu

Here is the Selective Leaching Sampling Methodology Report. Attachment 1 to the report is an Excel file that was too large to send together with the report file. So I will try and send it separately.

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<<LR_TR_540 Rev A-- Selective Leaching bindered.pdf>>

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LICENSE RENEWAL TECHNICAL REPORT

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Selective Leaching of Materials Program
Sampling Methodology

LR-TR-540

Revision A

Prepared by: _____ 02.11.2009
License Renewal Personnel / Date

Reviewed by: _____ 2-11-09
License Renewal Engineering Supervisor / Date

Approved by: _____ 2/11/09
License Renewal Project Manager / Date

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1.0 PURPOSE

The Prairie Island Nuclear Generating Plant (PINGP) Selective Leaching of Materials Program is a new aging management program (AMP), developed and implemented prior to the start of the period of extended operation. This AMP provides assurance that the intended functions of components susceptible to selective leaching are maintained during the period of extended operation. The program includes a one-time visual inspection and hardness measurement of selected components that are susceptible to selective leaching. In situations where hardness testing is not practical, alternate detection techniques may be used to determine the presence and extent of selective leaching. The inspections will determine if selective leaching is occurring for selected components.

The purpose of this document is to describe the PINGP approach for selecting sample size, sample location and inspection methods for completing the required component examinations.

Consistent with Section XI.M33 of NUREG-1801, Generic Aging Lessons Learned (GALL) Report (Reference 4.3), a Selective Leaching of Materials Program:

"… ensures the integrity of the components made of cast iron, bronze, brass, and other alloys exposed to a raw water, brackish water, treated water, or groundwater environment that may lead to selective leaching of one of the metal components. The AMP includes a one-time visual inspection and hardness measurement of selected components that may be susceptible to selective leaching to determine whether loss of materials due to selective leaching is occurring, and whether the process will affect the ability of the components to perform their intended function for the period of extended operation."

As an Exception to NUREG-1801, the PINGP Selective Leaching of Materials Program may use alternative detection techniques instead of, or in addition to, visual inspection and hardness testing for the detection of selective leaching. NUREG-1801 specifies use of only visual inspection and hardness testing. The PINGP program states that visual inspection and hardness measurement may not be feasible due to component configuration and location. In addition, other available detection techniques (e.g., mechanical scraping, chipping), and additional examination methods that become available to the nuclear industry, may be shown to be at least as effective as visual inspection and hardness testing in detecting and assessing the extent of selective leaching. (Reference 4.7)

The key elements of the program necessary for implementation include:

a. determination of the sample size based on an assessment of materials of fabrication (includes confirmation of material susceptibility), environment, and operating experience;

b. identification of the inspection locations in the system or component;

c. determination of the examination techniques, including acceptance criteria that would be effective in managing the aging effect; and

d. evaluation of the need for follow-up examinations to monitor the progression of any aging degradation including expansion of the inspection sample size and location.

This document describes the PINGP approach for completing elements “a” and “b” (i.e., determining the sample size and inspection locations necessary to fulfill the objectives for one-time inspections for selective leaching). Examination techniques, acceptance criteria and evaluation of inspection results (i.e., elements “c” and “d”) will be contained in a separate document, the *PINGP Selective Leaching of Materials Program Inspection Methods*. The PINGP Program Basis Document, LR-AMP-419, provides the basis for this aging management program.

2.0 BACKGROUND

Based on a review of EPRI 1010639, “Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools” (Reference 4.5) and other applicable guidelines such as EPRI 1007933, “Aging Assessment Field Guide” (Reference 4.4), selective leaching is the preferential dissolution of one element from an alloy. The two leading types of leaching are dezincification and graphitic corrosion (or graphitization).

Selective leaching or dealloying applies to components constructed of gray cast iron or copper alloy with greater than 15% zinc. The applicable degradation terms are dezincification for copper alloys and graphitic corrosion for gray cast iron.

Dezincification

Dezincification occurs in copper alloys in a more uniform manner where high zinc content and an acidic or other aggressive environment are present. Plug type dezincification occurs when lower zinc content and a less aggressive or alkaline environment is present. The zinc dissolves into solution and remains in solution. Some copper also dissolves but plates back onto the surface of the copper alloy. Dezincification can occur in clean water regardless of the presence of oxygen, though at an increased rate if oxygen is present. Copper-zinc alloys with zinc content in excess of 15% are susceptible to dezincification.

Graphitic Corrosion

Graphitic corrosion occurs in gray cast iron where the carbon content exceeds the solubility of the carbon in austenite at the eutectic temperature. Most cast irons of interest contain a minimum of 2% carbon, up to approximately 3.5% based on applicable ASTM standards. The graphite is cathodic to the iron, providing a galvanic cell. The iron is dissolved, leaving a porous mass consisting of graphite, voids and rust. If the cast iron is in an environment that corrodes metal rapidly, uniform corrosion can occur with loss of material strength as the cast iron can retain its appearance and shape but is structurally weaker. Scraping or chipping the surface is one method of detection which can reveal any crumbling of the iron beneath the surface.

3.0 DISCUSSION

In order to ensure a representative number of components are selected and examined for the presence of the selective leaching aging mechanism, a technical screening will be performed to pick a “smart sample” for each major material/environment combination. This “smart sampling” approach is based on the premise that inspection of those areas most susceptible to aging can be used to confirm whether or not selective leaching of materials is occurring in less susceptible areas. The review includes a documentation search to identify material and environment combinations meeting the threshold requirements for selective leaching to occur followed by a detailed check of component material composition. Those components most susceptible are then grouped by common material/environment and a sample is selected for inspection.

The review will be performed by qualified plant personnel knowledgeable in system design, operation, inspection results and overall material condition to evaluate the selected sample sizes and locations and appropriate examination techniques for each sample group. Results will be formally captured in meeting minutes and placed in the License Renewal (LR) Project files. Work Orders and maintenance procedures will be used to perform the required inspections. The overall process to satisfy elements “a” and “b” includes the following four steps described in more detail below:

- Step 1: Identify the In-Scope Components that Credit the Selective Leaching of Materials Program
- Step 2: Confirm Material Susceptibility
- Step 3: Identify Observable Characteristics
- Step 4: Define Sample Selection Strategy

Step 1: Identify the In-Scope Components that Credit the Selective Leaching of Materials Program

The LR systems that credit the Selective Leaching of Materials Program are listed in Table 1:

Table 1 Systems that Credit the Selective Leaching of Materials Program

Table 1 Systems that Credit the Selective Leaching of Materials Program	
Auxiliary Feedwater (AF) System	Fuel Oil (FO) System
Chemical and Volume Control (VC) System	Heating (HS) System
Circulating Water (CW) System	Main Steam (MS) System
Component Cooling (CC) System	Plant Sample (SM) System
Condensate (CD) System	Primary Containment Ventilation (ZC) System
Containment Spray (CS) System	Reactor Coolant (RC) System
	Residual Heat Removal (RH) System
Control Room and Miscellaneous Area Ventilation (ZN) System	Safety Injection (SI) System
Cooling Water (CL) System	Station & Instrument Air (SA) System
	Steam Generator Blowdown (SB) System
	Turbine Generator and Support (TB) System
	Waste Disposal (WD) System
Diesel Generators and Support (DG) System	Water Treatment (DE) System
Feedwater (FW) System	
Fire Protection (FP) System	

Components that credit the Selective Leaching of Materials Program are contained in ALEX, the License Renewal Equipment Database (LRDB), by unique tag number (SSC Tag) or asset group ID (e.g., FP-PIPES-BURIED-CI) on a system basis. These components are further identified on License Renewal Boundary Drawings.

Approximately 3,000 individual components (e.g., valve bodies, pump casings, piping, etc.) are presently included in the LRDB that credit the Selective Leaching of Materials Program. These components and assets were sorted from the LRDB by selecting those that credit the Selective Leaching of Materials Program for managing loss of material due to selective leaching (see Attachment 1).

During the Aging Management Review (AMR) process, definitive component material composition information was not readily available to accurately determine susceptibility to selective leaching. When a component's material composition could not be readily confirmed, the component was conservatively considered susceptible. This approach resulted in the inclusion of a considerable number of components whose composition was bronze, other copper alloys, or ductile cast iron that credited the Selective Leaching of Materials Program. Further review of these components is required to identify those with a material composition actually susceptible to selective leaching, and therefore subject to this AMP. These components will ultimately form the population from which the inspection sample will be selected. Those components determined to have a material composition that is not susceptible to selective leaching will not be subject to inspection.

The components listed in Attachment 1 are presently contained in twenty-four plant systems (see Table 1) and include copper alloys, gray cast iron or cast iron (when it could not be confirmed that the material is gray cast iron). However, especially for copper alloys, the actual material composition, specifically zinc content, must be determined to confirm susceptibility to selective leaching. This is accomplished in Step 2.

Step 2: Confirm Material Susceptibility

This step will confirm the material composition for components listed in Attachment 1. The majority of the effort will focus on the copper alloy components.

The copper alloy components require confirmation of material prior to performing inspections for selective leaching. A sample size is to be determined from copper alloy components listed in Attachment 1. The copper alloy population will be screened until a sufficient number of susceptible components have been identified. The purpose of this process is to select copper alloy components that have a composition of greater than 15% zinc and eliminate components that are not susceptible.

Attachment 1 includes a sufficient number of components composed of gray cast iron, such that no further effort will be expended to identify the material for components classified as "cast iron" (unconfirmed gray cast iron). The gray cast iron will be sampled for inspection.

Step 3: Identify Observable Characteristics

As noted in Section B2.1.36 of the PINGP LRA (Reference 4.6), one-time visual inspections and hardness measurements will be performed for components on a sampling basis. In situations where hardness testing cannot be performed due to component geometry, accessibility, etc., other available detection techniques (e.g., mechanical scraping, chipping) or examination methods may be used. If dezincification or graphitization is detected, then a follow-up examination will be performed. Confirmation of selective leaching may require a metallurgical evaluation, which may include a microstructure examination. In general, the following methods will be applied:

- For copper alloys, visual inspection looking for discoloration. Hardness testing of both the internal and external surfaces.

- For gray cast iron, visual inspection including scraping or chipping of the surface to check for crumbing of the iron beneath. Hardness testing of both the internal and external surfaces.

Step 4: Define Sample Selection Strategy

Proposed sampling strategies will be prepared by License Renewal personnel and then reviewed and finalized with input from plant personnel. Plant personnel experienced in system design, operation, material condition, prior inspection results, and the impact of aging effects on equipment performance will perform the reviews. Personnel selected will vary depending on the sample group or portion of a sample group to be reviewed. In general, System Engineers and Program Engineers knowledgeable of system material condition through the conduct of prior inspections will participate. Maintenance and operations personnel will be contacted to provide input as well in areas they have experience in conducting inspections. The objective of each review is to select a sufficient number of inspection locations to bound loss of material due to selective leaching.

Results will be used to prepare work orders, revise preventive maintenance procedures, and implement other actions to ensure that selective leaching inspections are performed prior to the period of extended operation. Inspection methods, inspector qualifications, acceptance criteria, evaluation techniques, and documentation requirements will meet the requirements defined in the program basis document (Reference 4.7). Sample locations and examination techniques chosen will be documented with appropriate justification. In selecting sample locations a number of factors will be considered including safety, ALARA, need for scaffolding, availability of other more accessible sample locations subject to the same conditions, planned equipment inspections and component replacement.

For all sample groups, if the inspection detects degradation, the results will be evaluated by Engineering. If acceptance criteria are not met, an Action Request will be prepared and evaluated through the Corrective Action Program. The evaluation will consider impacts on component intended function(s) over the period of extended operation. Unacceptable results will be evaluated further for extent of condition, need for additional inspections, etc. is not intended to be all inclusive but does identify some of the considerations for determining the inspection sample.

Table 2 Considerations in Selecting the Inspection Sample

Table 2 Considerations in Selecting the Inspection Sample	
Component Characteristic	**Attribute**
Materials of Construction	Material (percentages of different alloys present)
	Impurities or additives
Fabrication	Cast versus forged
	Coatings
	Residual stress
	Chemical cleaning or treatments
Environment	Applied stress (thermal, pressure, load)
	Chemistry (pH, oxygen level, impurities, inhibitors)
	Operating temperatures
Operating Characteristics	Stagnant/low flow area
	Wetting/drying
	Pressure, temperature, radiation
	Flow rate/turbulence
Equipment Age	Years in service
	System or similar component type operating experience

At least one component for each unique combination of make/model and material will be selected for inspection (e.g., Gould pump casing comprised of gray cast iron, Armstrong steam trap comprised of gray cast iron, etc.). As described previously, components selected for inspection must meet the material and environment threshold conditions for the possibility of selective leaching. As the fabrication process may vary by manufacturer and component type, this further distinction is appropriate for establishing sample size and locations.

All examinations will be performed using approved work orders. Results will be documented in the work order and evaluated by the Program Owner. Any conditions identified indicating the presence of selective leaching will be documented in an Action Request for further evaluation using the Corrective Action Program.

4.0 REFERENCES

4.1 10 CFR Part 54, “Requirements For Renewal Of Operating Licenses For Nuclear Power Plants”.

4.2 NUREG-1800, “Standard Review Plan For Review Of License Renewal Applications For Nuclear Power Plants”, Revision 1, September 2005.

4.3 NUREG-1801, Volume 2, “Generic Aging Lessons Learned (GALL) Report”, Revision 1, September 2005.

4.4 EPRI, Aging Assessment Field Guide, 1007933, December 2003.

4.5 EPRI, “Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools”, 1010639, Revision 4, January 2006.

4.6 Application for Renewed Operating Licenses, Prairie Island Nuclear Generating Plant, Units 1 and 2, April 2008.

4.7 License Renewal Aging Management Program Basis Document, LR-AMP-419, “Selective Leaching of Materials Program”, Revision 2.

4.8 MNGP Selective Leaching of Materials Aging Management Program, Sampling & Inspection Methods, Revision Draft 9/08.

Table 3 Open Items

TECHNICAL REPORT OPEN ITEMS			
Item	**Description**	**Status**	**LR AI No.**
1	Create the *PINGP Selective Leaching of Materials Program Inspection Methods* document described on page 4. Alternatively, incorporate elements c and d in this document and revise accordingly.	O	

Table 4 Revision Summary

Revision Summary		
Revision	**Section**	**Summary**
A	All	New Document

Attachment 1 – Components that Credit the Selective Leaching of Materials Program – Refer to "LR-TR-540, Selective Leaching Sampling, Attachment 1.xls" – (61 Pages)