UNITED STATES
NUCLEAR REGULATORY COMMISSION
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June 4, 2015

Mr. G.T. Powell, Vice President
Technical Support and Oversight
STP Nuclear Operating Company
P.O. Box 289
Wadsworth, TX 77483

SUBJECT: SELECTIVE LEACHING OF ALUMINUM BRONZE AGING MANAGEMENT PROGRAM 2015 AUDIT REPORT FOR THE SOUTH TEXAS PROJECT, UNITS 1 AND 2, LICENSE RENEWAL APPLICATION (TAC NOS. ME4936 AND ME4937)

Dear Mr. Powell:

By letter dated October 25, 2010, STP Nuclear Operating Company (STPNOC or the Applicant) submitted an application for renewal of operating licenses NPF-76 and NPF-80 for South Texas Project (STP), Units 1 and 2. The staff of the U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing this application in accordance with the guidance in NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" (SRP-LR).

The staff conducted a followup regulatory audit onsite from March 9-13, 2015, in order to gain a better understanding of the applicant's response to RAI B2.1.37-5. This RAI was issued as part of Open Item (OI) 3.0.3.3.3-1, "Insufficient details provided regarding applicant's Selective Leaching of Aluminum Bronze Aging Management Program (AMP)" in the SER with Open Items. This report can be found in the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML13045A356. The audit covered the AMP and associated aging management reviews, bases, and documentation as applicable. The audit report is enclosed.

If you have any questions, please contact me by telephone at 301-415-3873 or by e-mail at John.Daily@nrc.gov.

Sincerely,

/RA/

John W. Daily, Senior Project Manager
Reactor Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-498 and 50-499

Enclosure: As stated

cc: Listserv

Mr. G.T. Powell, Vice President
Technical Support and Oversight
STP Nuclear Operating Company
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Wadsworth, TX 77483

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DISTRIBUTION: See next page
ADAMS Accession No.: ML15131A145 *concurrence via email

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DATE	5/20/15	5/26/15	6/1/15	6/4/15	6/4/15

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Letter to G. Powell from J. Daily dated June 4, 2015

SUBJECT: SELECTIVE LEACHING OF ALUMINUM BRONZE AGING MANAGEMENT PROGRAM 2015 AUDIT REPORT FOR THE SOUTH TEXAS PROJECT, UNITS 1 AND 2, LICENSE RENEWAL APPLICATION (TAC NOS. ME4936 AND ME4937)

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U.S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION, DIVISION OF LICENSE RENEWAL

Docket Nos:	050-00498, 050-00499
License Nos:	NPF-76, NPF-80
Licensee:	South Texas Nuclear Operating Company
Facility:	South Texas Project, Units 1 and 2
Location:	P.O. Box 289 Wadsworth, TX 77483
Dates:	March 9 – 13, 2015
Reviewers:	J. Daily, Sr. Project Manager, Audit Team Leader, Division of License Renewal (DLR) W. Holston, Sr. Mechanical Engineer, DLR, Lead Reviewer C. Hovanec, Materials Engineer, DLR M. Homiack, Mechanical Engineer, RES M. Audrain, Mechanical Engineer, DE C. Nolan, Materials Engineer, DLR
Approved By:	Dennis Morey, Chief Aging Management of Reactor Systems Branch Division of License Renewal Yoira Diaz-Sanabria, Chief Projects Branch 1 Division of License Renewal

ENCLOSURE

Introduction

A one-week audit was conducted by the U.S. Nuclear Regulatory Commission staff (NRC or the staff) at the South Texas Project, Units 1 and 2 (STP, or the plant), near Wadsworth, TX, from March 9 – 13, 2015. The purpose of this audit was to examine the applicant's response to RAI B2.1.37-5, by letter dated July 31, 2014 (ADAMS Accession No. ML14224A151), along with associated materials, background, and supporting documentation for the aging management program (AMP). This followup audit focused primarily on materials and issues concerning the RAI response as needed in order for the staff to complete its review. Results of this audit will be ultimately documented in the staff's safety evaluation report (SER).

NUREG-1800, "Standard Review Plan for Review of License Renewal Applications" (SRP-LR), states that an applicant can choose to establish one or more plant-specific AMPs. For a plant-specific AMP, the applicant should ensure that the program contains adequate descriptions and depth of bases for all 10 elements of an AMP, in accordance with Branch Technical Position RLSB-1 in the SRP-LR, Appendix A.1. The applicant's evaluations and bases for this program are to be documented and maintained in an auditable, retrievable form.

The staff conducted this audit as a part of its overall evaluation of the AMP. During the audit the staff: reviewed the most recent revision of program elements one through seven of the Selective Leaching of Aluminum Bronze Program; examined applicant material test results, analytical methodologies, site implementing procedures, other relevant documents, and related references; interviewed various applicant representatives; and conducted breakout sessions on several issues related to selective leaching of aluminum bronze at STP.

A more detailed discussion follows.

Audit Activities. During this supplemental audit of the Selective Leaching of Aluminum Bronze Program, the staff interviewed the applicant's on-site and contractor staff, and reviewed on-site documentation provided by the applicant. The table below lists the documents that were reviewed by the staff and found relevant to the audit. These documents were provided by the applicant.

Relevant Documents Reviewed

Document	Title	Revision/Date
RC-9890	Stress Summary for Large Bore ECW Piping (2-1/2-inch and above)	Revision 1
MT-3047	Investigation of Dealloying in 6-inch Cast Aluminum Bronze Flange at South Texas Project Unit 2, and Cracking of this Flange welded to Wrought Pipe	May 10, 1991
MT-3047-2	Investigation of Dealloying in 6-inch Aluminum Bronze Flange and Cracking of this Flange welded to Wrought Pipe at South Texas Project Unit 1	May 10, 1991
ST-HL-HS-2779	Investigation of Leaks in Aluminum Bronze Flange from South Texas Project to Determine Extent of Dealloying	June 21, 1991
MT-3512A	Evaluation of Cracked Elbow-to-Nozzle Weld from South Texas Project Unit 1 Essential Cooling Water System	December 17, 1991

Document	Title	Revision/Date
MT-3512B	Evaluation of Cracked Aluminum Bronze Pipe-to-Pipe Weld from South Texas Project Unit 2 Essential Cooling Water System	January 8, 1992
ST-HL-HS-2828	Evaluation of Dealloyed and Cracked Aluminum Bronze Flange from South Texas Project Unit 2 Essential Cooling Water System	May 29, 1992
MT-3800	Evaluation of a Cracked Aluminum Bronze Repair Weld from South Texas Project Unit 1 Essential Cooling Water System	May 6, 1992
ST-HL-HS-2829	Evaluation of Two, 6-inch Aluminum Bronze Flange from South Texas Project Unit 2 Essential Cooling Water System	May 29, 1992
MT-4907	Mapping of Dealloying in Aluminum Bronze Pipe to Flange Weld Bend Test	December 10, 1993
MT-4089	Evaluation of Two, 6-inch Diameter Aluminum Bronze Pipe Flange from South Texas Project Unit 1 Essential Cooling Water System	November 19, 1992
MT-4046	Evaluation of 6-inch Diameter Aluminum Bronze Pipe Flange from South Texas Project Unit 2 Essential Cooling Water System	October 28, 1992
MT-3840	Evaluation of Two, 6-inch Aluminum Bronze Flange from South Texas Project Unit 2 Essential Cooling Water System	May 29, 1992
MT-4141	Evaluation of Dealloying in Welded Aluminum Bronze Cast Flange	December 23, 1992
MT-5050	Metallurgical Evaluation of Two Failed Aluminum Bronze Pipe Sections from ECW System at South Texas Project Unit 2	June 6, 1994
8804-06FA	Failure Analysis and Structural Integrity Evaluation of Leaking Small Bore Aluminum Bronze Cast Valve Bodies and Fitting in the ECW System	August 1988, Rev. 3
MT-3923	Evaluation of 6” Aluminum Bronze Flange from South Texas Project Unit 2 Essential Cooling Water System	October 13, 1992
MT-3383	Investigation of Leaks in Aluminum Bronze Flange from South Texas Project to Determine Extent of Dealloying	June 21, 1991
AES 12048100-2Q-2	Mechanical Testing of Dealloyed Aluminum Bronze Large Bore Castings in the Essential Cooling Water System	December 2013 Revision 0
AES 12048100-2Q-1	Structural Testing of 4-inch Aluminum Bronze Valves Removed from the Essential Cooling Water System	December 2013
AES 13078445-2Q-2	Profile Examination of 3-inch, 8-inch, and 10-inch Aluminum Bronze Flanges Removed from the Essential Cooling Water System	May 2014
AES 13078445-2Q-4	Surface Chemical Analysis of Dealloyed Aluminum Bronze Material Removed from the Essential Cooling Water System	August 2014
AES-C-1964-1	Calculation of Critical Bending Stress for Dealloyed Aluminum Bronze Castings in the ECW System	January 21, 1994
AES-C-1964-4	Evaluation of 6-inch Flange Test	June 3, 1994
AES-C-1964-5	Evaluation of the Significance of Dealloying and Subsurface Cracks on Flaw Evaluation Method	December 23, 1994

Document	Title	Revision/Date
AES 13078445-2Q-6	Structural Testing of Aluminum Bronze 4-inch and 6-inch Flanges, and 6x6x6-inch Tee Removed from the Essential Cooling Water System (Phase 3)	February 2015 Revision 0
ST-HL-HS-15094	Dealloying of 6" Aluminum Bronze Flanges South Texas Project Electric Generating Station	June 5, 1991
ST-HL-HS-002921	Metallurgical Evaluation of Two Failed Aluminum Bronze Pipe Sections from ECW System at South Texas Project Unit 2	June 6, 1994
ST-HL-HS-2884	Evaluation of Two 6-inch Diameter Aluminum Bronze Pipe Flanges from South Texas Project Unit 1 Essential Cooling Water System	November 19, 1992
Office Memorandum	Evaluation of Dealloying in Welded Aluminum Bronze Cast Flanges	December 23, /1992
AES 13078445-2Q-3	Mechanical Testing of Dealloyed Aluminum Bronze Large Bore Castings in the Essential Cooling Water System, and AES 12048100-2Q-2, Mechanical Testing of Dealloyed Aluminum Bronze Large Bore Castings in the Essential Cooling Water System	June 2014
SEM-2-91000145	PMWO ECW and ECW Screen Wash System – Visual Inspection System Piping	Revision 0B
SEM-1-9100041	PMWO ECW and ECW Screen Wash System – Visual Inspection System Piping	Revision 08
Chapter 9A	STP Updated Final Safety Analysis Report	Revision 15
0PGP04-ZA-0148	Aluminum Bronze Dealloying Management Program	Revision 1
33915401	50.59 Screen for Changes to UFSAR Appendix 9A	May 22, 2014
14-EW-003	Flood and Leak Rate Analysis for a Circumferential Crack in Aboveground ECW Piping	March 11, 2014
NOC-AE-14003135	Response to Requests for Additional Information for the Review of the South Texas Project, Units 1 and 2, License Renewal Application – Set 26	July 31, 2014
CR 12-22876	Residue Buildup Indicative of Through-wall Dealloying on the Cross-tie Side Flange of 2-EW-0274	June 12, 2012
CR 15-5464	Relief Request may have Been Required of Aluminum Bronze Components Identified in CR 14-4206	March 11, 2015
CR 15-5480	Procedure Feedback for 0PGP04-ZA-0148 Revision 1, Use of Code Case N-513 and no Direct Link from 0PGP04-002	March 11, 2015
9101835	Request for Action Through-wall Leak on 30-inch EW-1102 FW 0032	May 22, 1992
AES 13078445-2Q-1	Structural Testing of 3-inch, 8-inch and 10-inch Aluminum Bronze Flanges Removed from the Essential Cooling Water System	December 2015

During its audit, the staff reviewed program elements one through seven of the Selective Leaching of Aluminum Bronze Program. The staff verified the following:

a) The applicant's analytical methodology is adequate to demonstrate structural integrity of degraded components during the period of extended operation.
b) The applicant's methodology demonstrated that leakage from degraded components will not result in inadequate flow to downstream components.

c) The data point for a 10-inch flange documented in AES 13078445-2Q-1 partially supports the applicant's flaw size correlation.
d) Stress report RC-9890 demonstrates (pending resolution of material properties obtained by testing) that there is adequate structural integrity in dealloyed components in the absence of cracking.

For the "detection of aging effects," "monitoring and trending," "acceptance criteria," and "corrective actions" program elements of the LRA AMP, sufficient information was not yet provided to enable a staff conclusion of reasonable assurance that selective leaching of susceptible aluminum bronze components will be adequately managed during the period of extended operation. In addition, the staff was not able to resolve all issues associated with the analyses used to demonstrate structural integrity of degraded components and material property testing. In order to obtain the information necessary for the staff to complete its evaluation of these program elements, the staff will consider issuing RAIs for the subjects discussed below.

Monitoring and Trending and Acceptance Criteria AMP Elements: It is not clear to the staff that the parameters currently proposed to be monitored and trended are adequate. The percent of average internal dealloying and flaw size correlation are critical parameters used in AES-C-1964-1 and AES-C-1964-5 to demonstrate structural integrity when a through-wall leak is detected and they are not included in the list of parameters to be trended. It is not clear as to whether 100 percent dealloyed material properties used in these calculations will be monitored and trended because the program uses the term "and/or" for trending these parameters. In addition, it is not clear as to why there are no acceptance criteria for percent average dealloying and verification of the flaw size correlation to Figure 4-1 of AES-C-1964-5.

Percent Average Dealloying Inspection Results: The staff reviewed several reports that show average dealloying values that exceed the 60 percent input used in AES-C-1964-5. These values range from approximately 64 to 74 percent. The staff cannot conclude that the applicant's existing structural integrity calculations remain valid when some inspections have revealed average dealloying values that exceed the 60 percent value used in the current analysis.

Inspection Results Demonstrating the Acceptability of the Flaw Size Correlation: Figure 4-1 of AES-C-1964-5 contains a flaw-sizing curve which is used to relate the size of an indication found on the outside surface of a pipe to the amount of dealloying that has occurred on the inside of the pipe. This figure is based on data gathered in the 1990's from examinations of dealloyed pipes with through-wall cracks. During the audit the staff reviewed a report based on current testing; however, the staff found that other piping specimens that exhibited dealloying and through-wall cracks have since been tested and the new examination data from these tests has not been used to update or justify the continued use of Figure 4-1 of AES-C-1964-5. The staff needs to review this new data to determine if it conforms to the existing flaw-sizing curve.

Substantiation of 100 Percent Dealloyed Tensile Specimens: The staff has not been provided with a technical basis to substantiate the assumption that alloys susceptible to selective leaching only exist in two discrete conditions. The staff cannot conclude that the susceptible material only exists in two discrete conditions or that the dealloying

process has gone to completion in a region of reduced aluminum/iron based on a single traverse taken on a single specimen. The staff recognizes that material in the fully dealloyed condition will still have measurable amounts of aluminum and iron because not all of the phases present in the alloys are affected by the dealloying process. It is unclear to the staff if conclusions being drawn from Energy Dispersive Spectroscopy (EDS) traverses in dealloyed regions are based on elemental levels, degree of stability of the composition over a given length, or some other factor. In addition, the elemental composition of the 100 percent dimensionally dealloyed tensile specimen (10x10x6 tee, piece number 3, Alloy CA952) has not been evaluated to determine if the dealloying process has gone to completion. This tensile specimen was used to produce the only yield strength value for 100 percent dimensionally dealloyed material measured to date, as shown in the plots on page 6 of Enclosure 1 in the applicant's RAI Response Set 26, dated July 31, 2014.

Strength vs. Percent Dealloyed Curves: The tensile, yield strength, and ultimate tensile strength values for the C95200 and C95400 alloys tested by STP are provided in RAI Response Set 26, Enclosure 1, dated July 31, 2014. The strength values are plotted on pages 5 and 6 of Enclosure 1. A regression analysis of the strength data has been performed on each plot. The staff has several questions related to the data, including: (a) whether the data sets are being treated as a single data set or multiple data sets when determining strength values as a function of percent dealloying; (b) the basis for the type of regression analysis used to determine the relationship between strength and percent dealloying; (c) use of the 0.2 percent offset method and the 0.5 percent extension under load (EUL) method; and (d) the basis used to conclude that the 100 percent dealloyed yield strength value utilized in the structural integrity calculations to support operability evaluations is bounding for the susceptible components in operation.

AMP Acceptance Criteria for Strength: It is unclear to the staff how acceptance criteria of 30 ksi can be established for ultimate tensile strength and yield strength properties when current plant-specific data shows values below the acceptance criteria.

Basis for Use of the Average Dealloying Angle in Structural Integrity Analyses: The response to RAI B2.1.37-5, part f, dated July 31, 2014, cites Generic Letter 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping," and ASME Code Section XI, Appendix H, "Evaluation of Procedures for Flaws in Piping Based on Use of a Failure Analysis Diagram," as the basis for using the average through-wall dealloying angle instead of the inside wall dimension in AES-C-1964-5. The staff cannot conclude that ASME Code Section XI, Appendix H (a methodology used to evaluate partial through-wall indications) provides a basis for use of an average through-wall dealloying angle because it lacks specificity to demonstrate acceptance of an average flaw size. Generic Letter 90-05 cites a flaw length, 2a, which is based on the dimensions of the flaw at the minimum pipe wall thickness. However, Generic Letter 90-05 is based on a process where the flaw can be characterized by volumetric measurements. In the case of selective leaching of castings, it is unlikely that volumetric characterization of the flaw would be possible, and if it were possible, the flaw-sizing correlation from Figure 4-1 of AES-C-1964-5 would not be necessary. A sufficient basis for use of the average dealloying angle has not been provided.

Implementing Procedures Related to System Walkdowns and Design Verification of As-Found Conditions: During the audit, the staff reviewed plant-specific implementing procedures. The staff has questions on: (a) whether all susceptible components or description of components are listed in Preventive Maintenance Work Order (PMWO) SEM-1-9100041 and PMWO SEM-2-9100045; (b) the basis for use of Code Case N-513-3 to determine the acceptability of components exhibiting through-wall flaws; and (c) whether there are any flaw sizes that would be acceptable from a structural integrity basis but not acceptable to ensure that the leakage rate from a degraded component is below administrative limits and, if this is the case, state how the leakage rate flaw size acceptance criteria will be incorporated into the program.

Scope Expansion Criteria: With respect to the "corrective actions" program element, SRP-LR Section A.1.2.3.7 states that actions to be taken when the acceptance criteria are not met should be described in appropriate detail or referenced to source documents. However, the "corrective actions" program element of the Selective Leaching of Aluminum Bronze Program does not describe the extent of condition testing that will be conducted when degraded components are detected.

Clarification of Licensing Basis Related to Use of Partially Dealloyed Material Properties: It is not clear to the staff whether partially dimensionally dealloyed mechanical properties (i.e., ultimate tensile strength, yield strength, and fracture toughness) will be used during the period of extended operation to demonstrate the structural integrity of aluminum bronze components.

Applicant response concerning samples collected for profile examinations or analysis confirmatory tests: Finally, the response to RAI Set No. 26, dated July 31, 2014, states that the applicant has not collected the quantity of samples recommended by the staff for profile examinations (PEs) and analysis confirmatory tests (ACTs) prior to issuance of the SER. The applicant proposed to continue testing after the SER is issued until the recommended number of tests is completed. The staff did not evaluate this proposal during the supplemental audit, and does not plan to issue an RAI to address the gap. The staff will evaluate the information it obtained during the supplemental audit and the response to the followup RAIs before evaluating this proposal. At the current time, the staff's position has not changed; absent the results of further PEs and ACTs, the staff lacks reasonable assurance to conclude that the program will be adequate.

Audit Results. Based on this supplemental audit, the staff verified that the applicant's analytical methodologies are adequate to demonstrate: (a) structural integrity of degraded components during the period of extended operation; and (b) that leakage from degraded components will not result in inadequate flow to downstream components. The staff has remaining questions on the methodology used to determine 100 percent dealloyed material properties. The staff also identified certain aspects of the "detection of aging effects," "monitoring and trending," "acceptance criteria," and "corrective actions" program elements of the LRA AMP for which additional information or additional evaluation is required before the staff can complete its evaluation of the LRA AMP.