UNITED STATES
NUCLEAR REGULATORY COMMISSION
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April 12, 2012

Mr. D. W. Rencurrel
Sr. Vice President, Technical
Support and Oversight
STP Nuclear Operating Company
P.O. Box 289
Wadsworth, TX 77483

SUBJECT: REQUESTS FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE SOUTH TEXAS PROJECT, UNITS 1 AND 2, LICENSE RENEWAL APPLICATION – AGING MANAGEMENT, SET 16 (TAC NOS. ME4936 AND ME4937)

Dear Mr. Rencurrel:

By letter dated October 25, 2010, STP Nuclear Operating Company (STPNOC or the applicant) submitted an application pursuant to Title 10 of the *Code of Federal Regulations*, Part 54, to renew operating licenses NPF-76 and NPF-80 for South Texas Project, Units 1 and 2, for review by the U.S. Nuclear Regulatory Commission (NRC or the staff). The staff is reviewing the information contained in the license renewal application and has identified, in the enclosure, areas where additional information is needed to complete the review.

These requests for additional information were discussed with Arden Aldridge, and a mutually agreeable date for the response is within 30 days from the date of this letter. If you have any questions, please contact me at 301-415-3873 or by e-mail at john.daily@nrc.gov.

Sincerely,

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

Docket Nos. 50-498 and 50-499

Enclosure:
As stated

cc w/encl: Listserv

SOUTH TEXAS PROJECT, UNITS 1 AND 2,
REQUEST FOR ADDITIONAL INFORMATION
AGING MANAGEMENT, SET 16
(TAC NOS. ME4936 AND ME4937)

Selective Leaching of Aluminum Bronze Program (111)
RAI B2.1.37-3

Background

The December 8, 2011, responses to RAIs B2.1.37-1 and B2.1.37-2 lacked sufficient detail for the staff to complete its evaluation of the plant-specific Selective Leaching of Aluminum Bronze program. The staff conducted a supplemental audit of this program on February 29, 2012. During its audit, the staff interviewed STP staff and reviewed documentation related to (a) the mechanism of the selective leaching phenomenon, (b) operating experience of aluminum bronze piping component leaks, (c) analyses performed to verify structural integrity when leaks are identified, and (d) current and future inspection activities. As a result of this audit, the staff has the following issues and requests for additional information.

Issue

a. Based on material reviewed during the audit, the staff lacks sufficient understanding of the phase composition of the material as it relates to which phase is dealloying. The staff believes that the nature and distribution of phases may be critical to the characteristics and extent of selective leaching in the components. To date, the applicant has not provided sufficient information to the staff to document the metallurgical issues associated with the observed degradation with sufficient accuracy to assess the current conditions of the components and to manage their aging in the future. For example, if a significant fraction of the material is $\gamma 2$, and the $\gamma 2$ undergoes leaching, then the material strength could be in question. A better understanding of the phase composition and the specific phases susceptible to dealloying is necessary for the staff to reach a conclusion on the strength of the material.

b. Based on the concept that only certain phases of aluminum bronze are susceptible to selective leaching, the existence of through-wall leakage appears to indicate that the leachable phase is a continuous phase. The staff is uncertain as to the method utilized to obtain the ultimate tensile strength of fully dealloyed components. No yield strength was provided to the staff from these tests. In addition, the staff lacks sufficient details to conclude that the ultimate tensile strength measurements conducted in November 1988 are sufficiently conservative for components that have continued in service for an additional 22 years or for the period of extended operation ending in 2048.

c. During the audit, flaw propagation in the degraded area was sometimes described as dealloying and sometimes as cracking accompanied by dealloying. The staff is not clear on how the flaw is propagating.

d. Based on the review of eight structural calculations during the audit, the staff believes that there are certain inputs, assumptions, and analytical methodologies that could allow non-conservative results in the analyses used to demonstrate structural integrity of dealloyed components. The staff lacks sufficient information to determine if this impacts

the ultimate conclusion of structural integrity throughout the period of extended operation. The staff's concerns regarding these inputs and methodologies include:

- Use of the assumed ultimate tensile stress of completely dealloyed regions, rather than flow stress, could result in a non-conservative moment at failure in the net section collapse analyses.

- It does not appear that dealloyed fracture toughness values were obtained or used in the analyses. Given the potential presence of cracks, the critical bending stress analyses could be non-conservative.

- It appears that a structural factor (also known as safety factor or design factor) was not used in the analyses. The only analysis that the staff reviewed which provided a margin was AES-C-1964-4, which was a test of a 6-inch flange conducted in May 1994. This analysis states that there is a 1.21 margin between measured and predicted failure. The staff does not believe that the test provided sufficient rigor to demonstrate that there is adequate margin between measured and predicted failure because:

    i. Only one 6-inch flange was tested, when susceptible flanges range from 3-inch to 30-inch. The experimental test size is not sufficient to provide a statistical basis to determine the uncertainty in the failure loads. This uncertainty is needed to ensure sufficient conservatism for extended life.

    ii. The specimen had 35 to 90 percent, with an average of 50 to 70 percent, dealloying instead of 100 percent dealloying.

    iii. Testing was conducted in 1994, which may not envelope the degree of degradation of components that will remain in service until 2048, the end of the renewed license period.

e. The staff does not believe that external visual inspections are sufficient to establish a subsurface crack configuration. Specific staff concerns arising from the audit are as follows:

- A correlation between outside diameter crack length and average degradation length through the wall of the component was derived in calculation AES-C-1964-5. It appears that only seven flanges were metallurgically sectioned to develop this correlation. It also appears that only two flange sizes were examined, 6-inch and 8-inch. The staff does not believe that the number of tested specimens was statistically significant given the population of susceptible components, and therefore cannot accept this correlation given the current understanding of available information.

- In many instances, upon detecting indications of leakage on the outside surface of the component, it would have been possible to perform volumetric examinations and thereby eliminate ambiguity on the subsurface dimensions of a crack. It is therefore the staff's belief that a correlation (as developed in the

response to item d, above, should only be used in instances where the configuration of the component prevents the utilization of volumetric crack sizing.

- In some instances from at least 1997 through 2011, the detection of indications of leakage on the outside surfaces of components was characterized as several pinpoints. During the audit, it appeared to the staff that as long as the pinpoints were separated by enough distance, they were not treated as a single planar flaw. This was justified by referring to American Society of Mechanical Engineers (ASME) Section XI criteria such as contained in IWA-3000. The staff does not believe it is appropriate to apply these criteria unless volumetric examinations have been conducted in order to characterize the flaw size throughout the wall of the component.

- Calculation AES-C-1964-1, Figure 7-1 demonstrated that dealloyed components where a crack was not present have a much higher load capacity. The staff believes that volumetric inspections to confirm the absence of cracks should be a part of the aging management program.

f. Based on a review of plant-specific operating experience, there were at least six instances of cracking occurring downstream of butterfly valves, apparently due to cavitation loads. The staff does not know whether dealloying was associated with these locations.

g. In the response to RAI B2.1.37-1, LRA Sections A1.37 and B2.1.37 were revised to include destructive examination of one through-wall dealloyed component per unit if leakage occurs during the 10-year period prior to extended operation. In addition, if leaks occur during the period of extended operation, up to an additional two components per unit will be destructively examined. The staff has the following concerns in relation to the proposed destructive examinations:

- The sample size is not sufficient to provide a statistical basis for the extent of further dealloying or crack propagation that will continue to occur.

- Regardless of whether leakage occurs in the 30-year period starting 10 years prior to the period of extended operation, destructive sampling should be performed to validate the extent of further degradation. The staff recognizes that if no leaks occur between the issuance of the new license and this period, the sample size could be less than if leaks continue to occur.

- The wording of Commitment No. 39 is not rigorous enough in that four leaks could occur in the first year of extended operation and no further components would be examined. The staff believes that a minimum inspection sample should be specified for each 10-year period of extended operation.

- Using samples from the existing inventory of removed components would not be representative of installed components, since the existing inventory has not been exposed to the raw water environment as long as installed components have been. Alternatively, the staff would expect that if no leak sites occur within the

final 10 years of the initial licensing period, then a risk ranked approach would be used to remove non-leaking components that are most susceptible to degradation for metallurgical analysis.

- The Updated Final Safety Analysis Report (UFSAR) supplement should have the same specificity as that in LRA Section B2.1.37. In this regard, the response to this RAI part e, fourth bullet should be integrated into these changes.

h. The RAI response for flooding, reduction in flow, and water loss from the essential cooling pond did not state the basis for why the medium energy break size flaw stated in UFSAR Appendix 9A is larger than the maximum size flaw for which the piping can still perform its current licensing basis (CLB) function. In addition, given that multiple leak sites are allowed by the program, the response did not provide the basis for why only one through-wall, and not multiple through-wall defects, is acceptable in analyzing the impact of flooding, reduction in flow, and water loss from the essential cooling pond. Any given dealloyed leak site with a crack could grow to critical size under seismic loading conditions and therefore the flow rate from the degraded site could increase beyond that observed during normal operation. This response should factor in the response to other questions in this RAI relating to assumed material properties as they could affect calculation AES-C-1964-7.

i. SRP-LR Section A.1.2.3.5, Monitoring and Trending, states that, "[m]onitoring and trending activities should be described, and they should provide a prediction of the extent of degradation and thus effect timely corrective or mitigative actions." It also states, "[t]he methodology for analyzing the inspection or test results against the acceptance criteria should be described." SRP-LR Section A.1.2.3.6, Acceptance Criteria, allows for quantitative or qualitative acceptance criteria; however, as stated in other portions of this RAI, when through-wall leakage is discovered, volumetric examinations should be performed when the configuration allows for crack sizing. As such, the AMP should be modified to reflect these criteria.

j. During the audit, the staff utilized the information in the document titled, "ECW De-alloying and Weld Crack Data Tables Clarification," although this information is not available on the docket.

Request

a. State the phase composition of the material of the susceptible components (e.g., $\gamma 2$, β, α). State which phase(s) of the material are significantly present, which phase is the continuous phase, and which phase(s) are leached. Given the composition of the dealloyed components identified to date, state the basis for why the ultimate tensile strength used in the structural analysis of the degraded components is a conservative value. Provide metallurgical analyses including micrographs and chemical analyses sufficient to demonstrate an understanding of the phase distributions, including whether phases are continuous or discontinuous, near areas in which dealloying and/or cracking has been observed and the extent of selective leaching in those phases.

b. In relation to tensile material properties, respond to the following:

- In light of the probability (based on through-wall leakage) that the selectively leached phase is continuous, justify how 100 percent leached material will have any tensile strength given that leaching will form a continuous path from the ID to the OD of the pipe.

- Justify why the tensile strength which will exist in in-service components in 2048 is accurately described by a tensile test conducted in 1988, when it appears likely that selective leaching is continuing in the affected components.

- Describe the manner in which the tensile tests were conducted such that an ultimate tensile strength was reported and that yield strength was not reported.

c. For each of the dealloyed castings, weld repair regions of extruded tees, and dealloyed socket weld adaptor configurations, describe the initial flaw morphology (e.g., dealloying, crack) and state how the flaw propagates. Describe whether the through-wall flaws are developed only from through-wall dealloying degradation, i.e., 100 percent dealloying through thickness, or by cracking mechanisms such as stress corrosion cracking or fatigue. If cracking has been observed to occur at the 100 percent dealloyed condition, further justify the 30ksi ultimate tensile strength of 100 percent dealloyed material. If all of the extruded weld repair and socket weld adaptors susceptible to dealloying have been replaced with materials that are not susceptible to dealloying, no response is required for these configurations.

d. Provide one of the following, including completion dates, appropriate commitments, and UFSAR supplement changes, if portions of the following will not be completed prior to the conclusion of the staff review of the LRA. Include in the commitments and UFSAR supplement that final analyses or testing results will be submitted for approval by the staff 2 years prior to the period of extended operation.

- Analyses using fully dealloyed properties for all critical inputs (e.g., flow stress, fracture toughness) and an appropriate structural factor. State how the fully dealloyed properties will be obtained.

- Analyses using partially dealloyed properties for critical inputs and an appropriate structural factor. State how the properties for the dealloyed portion will be or were obtained. In addition, state the basis for how the Selective Leaching of Aluminum Bronze program will confirm that the assumed upper limit of partial dealloying will not be exceeded throughout the period of extended operation.

- Implement a mechanical testing and metallurgical examination program that includes the following aspects at a minimum:

    - Test the full range of sizes of degraded components.
    - Test a statistically significant number of degraded components.
    - Ensure that the maximum extent of expected dealloying is present in the test specimens.

- o Extend the testing program and field verification of as-found degradation through the period of extended operation and closely couple these activities to ensure that further dealloying is not exceeding the parameters (e.g., percent of dealloying, crack size) of the tested components.

If this option is selected, appropriate changes must be made to the LRA program.

- Propose an alternative means to demonstrate structural integrity through the period of extended operation with consideration of the issues raised in this RAI.

e. Respond to the following in relation to the program being based on external visual examinations:

- State the basis for why a sample size of seven 6-inch and 8-inch flanges is adequate to develop a correlation between outside diameter indications and average degradation length through the wall of the component, or propose the basis for an alternative sample population and conduct/propose further testing.

- Describe when the above correlation will be used, rather than conducting volumetric exams to size any subsurface cracks, when leaks are discovered.

- In the absence of volumetric examinations to size any subsurface cracks, and where external leakage is characterized by multiple pinpoints (or larger indications), state the basis for assuming that the subsurface flaws are not considered a singular indication.

- State the basis for why volumetric inspections to confirm the absence of cracks are not part of the aging management program, or revise the program to include these examinations, including sample size, selection of locations, and frequency.

f. State the cracking mechanism which occurred downstream of butterfly valves due to cavitation loads and whether dealloying was associated with the cracking. If yes, state if these occurrences were reflected in RAI Response B2.1.37-1, Table 1. If dealloying was associated and the occurrences were not included in Table 1, please revise the table.

g. Revise LRA Sections A1.37 and B2.1.37, and Commitment No. 39 to reflect:

- A sample size that is sufficiently statistically-based to confirm that the extent of further dealloying or crack propagation is known.

- State the basis for why destructive sampling will only be conducted if leakage occurs, or, for both leakage and non-leakage scenarios, state the number of samples that will be destructively examined in each 10-year period starting 10 years prior to the period of extended operation.

- State the timing of destructive examinations that will occur throughout each 10-year period.

- State the basis for why using samples from the existing inventory, which have not been exposed to the raw water environment for as long as in-service components, in lieu of removing a component from service that is in a location susceptible to degradation (e.g., locations adjacent to previous leaks), is acceptable. State the maximum time that the component would be allowed to have been removed from service and still be included in destructive examinations to characterize the extent of continued dealloying.

- For the periodic volumetric examinations, define the sample size, selection of locations, and frequency.

- As related to the above five bullets, the UFSAR supplement should clearly refer to or contain the same specificity as that in the revised LRA Section B2.1.37.

h. For the flooding, reduction in flow, and water loss from the essential cooling pond analyses, state the basis for why the medium energy break size flaw stated in UFSAR Appendix 9A is larger than the maximum size flaw for which the piping can still perform its CLB function. State the basis for why only one through-wall, and not multiple through-wall defects, is acceptable in analyzing the impact of flooding, reduction in flow, and water loss from the essential cooling pond. This response should factor in the response to other questions in this RAI relating to assumed material properties as they could affect calculation AES-C-1964-7.

i. With consideration of responses to other questions in this RAI, provide the appropriate detail for the "monitoring and trending" and "acceptance criteria" program elements in the Selective Leaching of Aluminum Bronze program.

j. Submit the document titled, "ECW De-alloying and Weld Crack Data Tables Clarification" with the response to this RAI.

Letter to D. W. Rencurrel from John W. Daily dated March xx, 2012

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Sincerely,

/RA/

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

Docket Nos. 50-498 and 50-499

Enclosure:
As stated

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