STP Nuclear Operating Company

South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

May 31, 2012
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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 1 and 2
Docket Nos. STN 50-498, STN 50-499
Response to Requests for Additional Information for the
South Texas Project License Renewal Application
Aging Management Program, Set 16 (TAC Nos. ME4936 and ME4937)

References: 1. STPNOC letter dated October 25, 2010, from G. T. Powell to NRC Document Control Desk, "License Renewal Application" (NOC-AE-10002607) (ML103010257)

2. NRC letter dated April 12, 2012, "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 ME 4937)"(ML12087A141)

By Reference 1, STP Nuclear Operating Company (STPNOC) submitted a License Renewal Application (LRA) for South Texas Project (STP) Units 1 and 2. By Reference 2, the NRC staff requests additional information for review of the STP LRA. STPNOC's response to the requests for additional information is provided in Enclosure 1 to this letter. Changes to LRA pages described in Enclosure 1 are depicted as line-in/line-out pages provided in Enclosure 2.

One new regulatory commitment and one revised regulatory commitment are added to Table A4-1 of the LRA and are provided in Enclosure 3 to this letter. There are no other regulatory commitments in this letter.

Should you have any questions regarding this letter, please contact either Arden Aldridge, STP License Renewal Project Lead, at (361) 972-8243 or Ken Taplett, STP License Renewal Project regulatory point-of-contact, at (361) 972-8416.

A147
NRR

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 5/31/2012
Date

D. W. Rencurrel
Chief Nuclear Officer

KJT

Enclosures:
1. STPNOC Response to Requests for Additional Information
2. STPNOC LRA Changes with Line-in/Line-out Annotations
3. New Regulatory Commitment

cc:

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Enclosure 1

STPNOC Response to Requests for Additional Information

Attachments:

A. List of References

B. "ECW Dealloying and Weld Crack Data Tables Clarification Aluminum – Bronze RAI Response (Tables)"

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 Dealloying and Weld Crack Data Tables Clarification," although this information is not available on the docket.

<u>Request:</u>

<u>NRC RAI</u>

a. State the phase composition of the material of the susceptible components (e.g., γ2, β, a). 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.

STPNOC Response

The following discusses the phase composition of the material of the susceptible components.

The aluminum bronze alloys used at STP contain approximately 8% to 11% aluminum, having additions of iron, nickel, and manganese. These alloys typically have good corrosion resistance but they vary in this respect according to their metallurgical structure which in turn depends upon the composition of the material and its manufacturing history - especially the thermal treatment to which they have been subjected.

The simple aluminum bronzes containing only copper and aluminum have a single phase (alpha) structure up to about 8% aluminum. Above that level, a second phase (beta) is formed producing an alpha-beta alloy. In brasses, the formation of beta phase typically results in reduced corrosion resistance. When an alpha-beta aluminum bronze is allowed to cool too slowly from temperatures above about 600°C, which was the case for South Texas Project (STP) aluminum bronze castings, the beta phase converts to a mixture of alpha and gamma 2 phases at around 565°C. The gamma 2 phase has a higher aluminum content than the beta phase and shows a susceptibility to corrosion. Small isolated areas of gamma 2 phase will result in localized superficial corrosion, but this will not penetrate into the body of the material.

If gamma 2 is allowed to form as a continuous network, a higher rate of penetration of corrosion through the alloy can occur. Vendors responsible for castings have minimized formation of a continuous network of gamma 2 by maintaining the aluminum content below 9.1%. The corrosion behavior of alloys containing between 8.7 and 9.1% aluminum is variable depending upon the cooling rate. In this range of aluminum composition, the gamma 2 phase is discontinuous even at the slowest cooling rates likely to be found in commercial practice.

Rapid cooling (e.g. water quenching from 600°C after casting or hot working) can eliminate the gamma 2 phase in material of higher aluminum content. Alternatively, for material containing gamma 2 resulting from a slow cooling rate after casting, the gamma 2 phase can be reformed to the beta phase by reheating to hot working or welding for a sufficient length of time followed by quenching. The presence of iron in sufficient quantity (about 2%) in the material also suppresses the formation of gamma 2 and refines the grain structure of the alloy. As a result, any gamma 2 present in the material is more likely to be in a discontinuous form. Nickel has an effect similar to that of iron in suppressing formation of gamma 2. Manganese additions also suppress the breakdown of beta phase to alpha plus gamma 2 but, at the same time, modifies the character of the beta making it more susceptible to corrosion. Therefore, manganese content chosen must give the optimum balance between these two effects. The suggested manganese content is less than 0.75%.

The above comments concerning the formation of gamma 2 phase with resultant deterioration of corrosion resistance apply only to binary aluminum bronzes (i.e., alloys of copper and aluminum without additional alloying elements).

Aluminum bronze components at STP have approximately 4% iron as noted in Component Material Test Reports (CMTR). Emission spectrographic analysis of the base metal of an STP valve determined the component contained 4.25% by-weight iron, 0.06% by-weight nickel, and 0.11% by-weight manganese content (see Table A-1). Nickel has a similar effect to iron in suppressing the formation of gamma 2.

STP performed confirming emission spectrographic analysis of base metal of valve EW-269. The chemical analysis results are as follows:

Table A-1

Element	Cu	Al	Fe	Mn	Ni
% Weight	84.9	10.6	4.25	0.11	0.06

Table A-2 on the following page lists details of samples of STP components for which microstructures were developed.

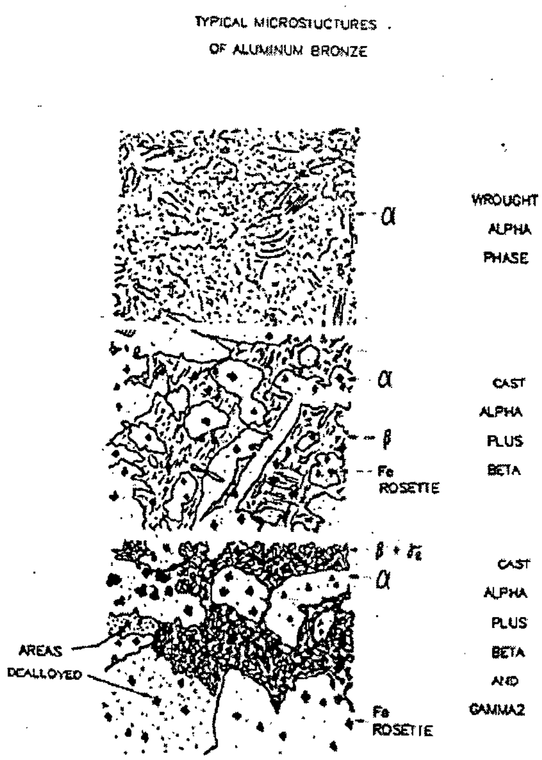
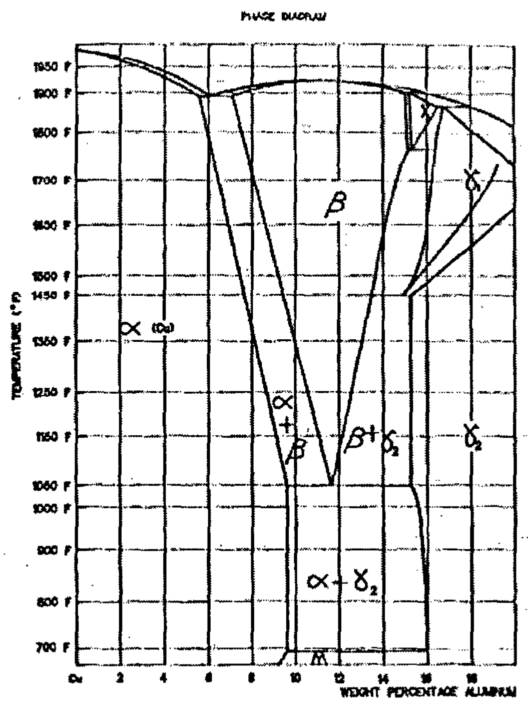
Table A-2

Analysis Of Cross Sections of Initial Samples							
Serial No. Project ID No.	**Valve or Fitting Heat No.**	**Type of Cross Section**	**Worst Case Local Penetration of Dealloying**	**Metallurgical Structure**	**Location of Cross Section**	**Photomicrographs**	**Mount No.**
61-382 EW 269	Valve H5174-44	Circumference 100 to 200 degrees	27% 0.12 in.	Alpha and Beta 50%/50%	Leaking ends	Continuous network of beta dealloying and minor pits	7040
466-185 EW-315	Valve H5174-36	Longitudinal at 180 degrees bronze valve to bronze pipe	50% Some were 25%	Alpha and beta and small grey dots in both phases 50%/50%	No leak	Continuous network of beta dealloying	7043

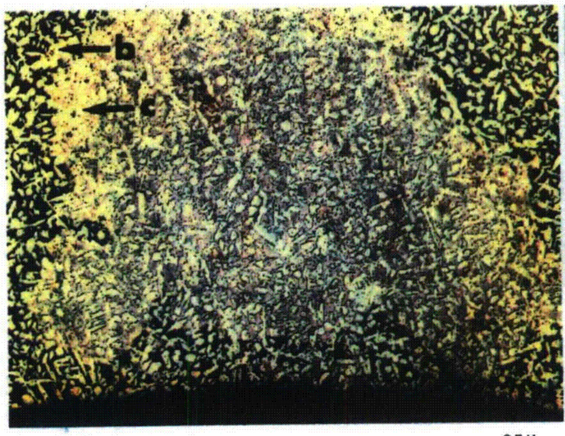
The data in Table A-2 show that the extent of dealloying in the samples were variable and that the metallurgical phases are the same as material sampled in 2012 (see pages 13 and 14 of this enclosure).

Figure A-1 provides a typical microstructure and phase diagram of aluminum bronze castings.

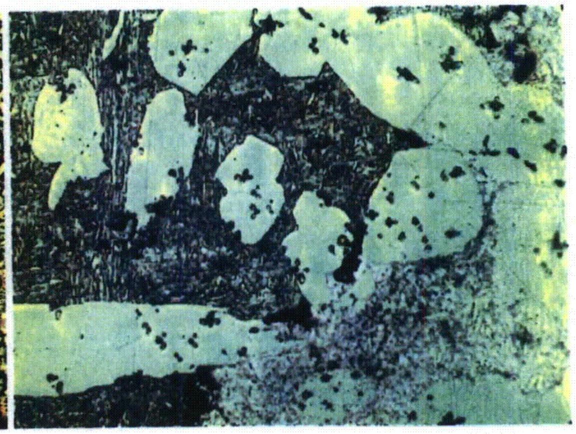
Figure A-1

Typical Microstructure and Phase diagram of Aluminum Bronze Castings	
Microstructures	Phase Diagram
	

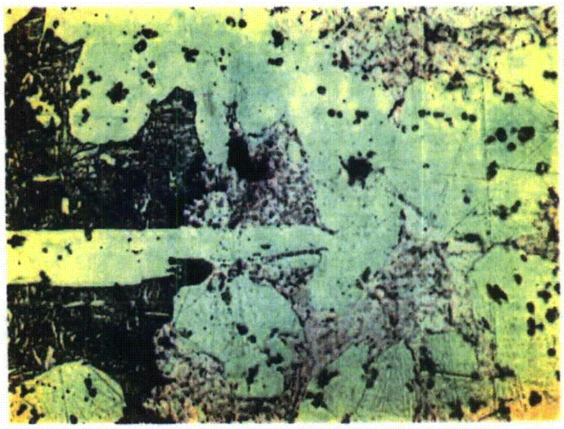
Micrographs of EW-269 and EW-315 valves in Table A-2 are provided below.



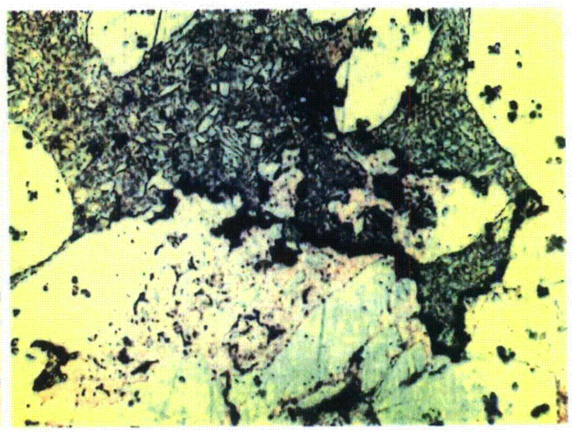
(a) 25X



(b) 500X



(c) 500X



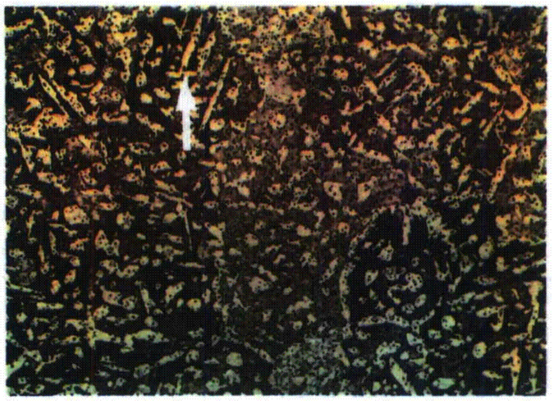
(d) 500X

Figure 38 (a) A dealloyed area near the inside surface of Valve EW269
(b) & (c) The areas marked by the arrows in (a).
(d) A beta grain with partial dealloying

Mount No. 7040

Valve EW269

CA954



(i) 50X

(j) 250X

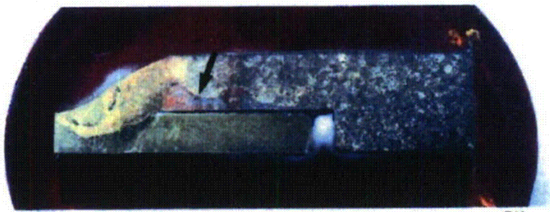
(k) 500X

Figure 39 A typical area without dealloying in Valve EW315. (j) and (k) show the area marked by the arrow in (i).

Mount No. 7043

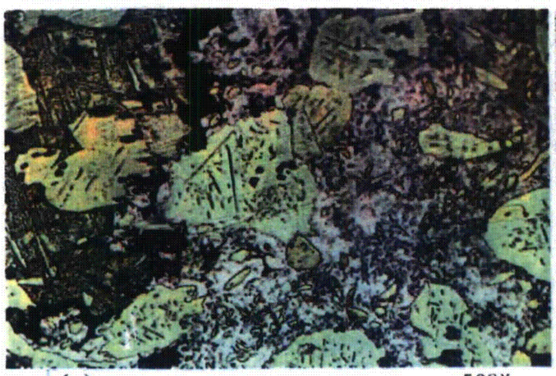
Valve EW315

CA954

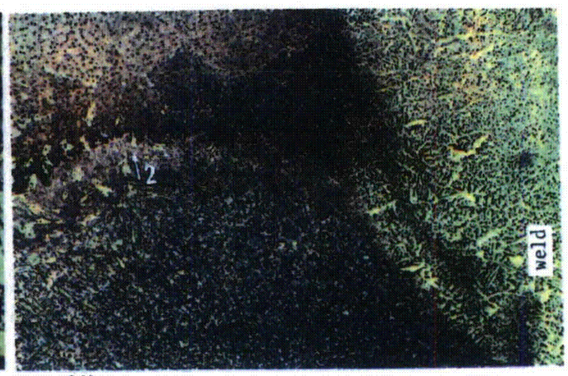


(a) 3X

(b) 25X



(c) 500X



(d) 50X

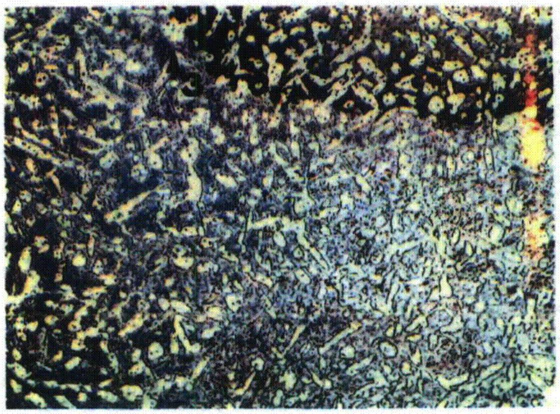
Figure 39 (a) Macrograph of a weld in Valve EW315 showing dealloying (arrow).
(b) The dealloyed area shown in (a).
(c) End of dealloying marked by arrow "1".
(d) The area marked by arrow "2".

Mount No. 7043 Valve EW315

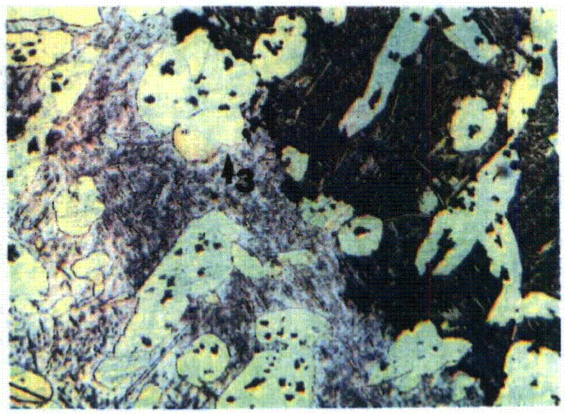
CA954

(e) 500X

(f) 250X



(g) 50X



(h) 250X

Figure 39 (e) & (f) The area marked by arrow "2" in (a) before and after etching
(g) & (h) The area marked by arrow "3" in (a).

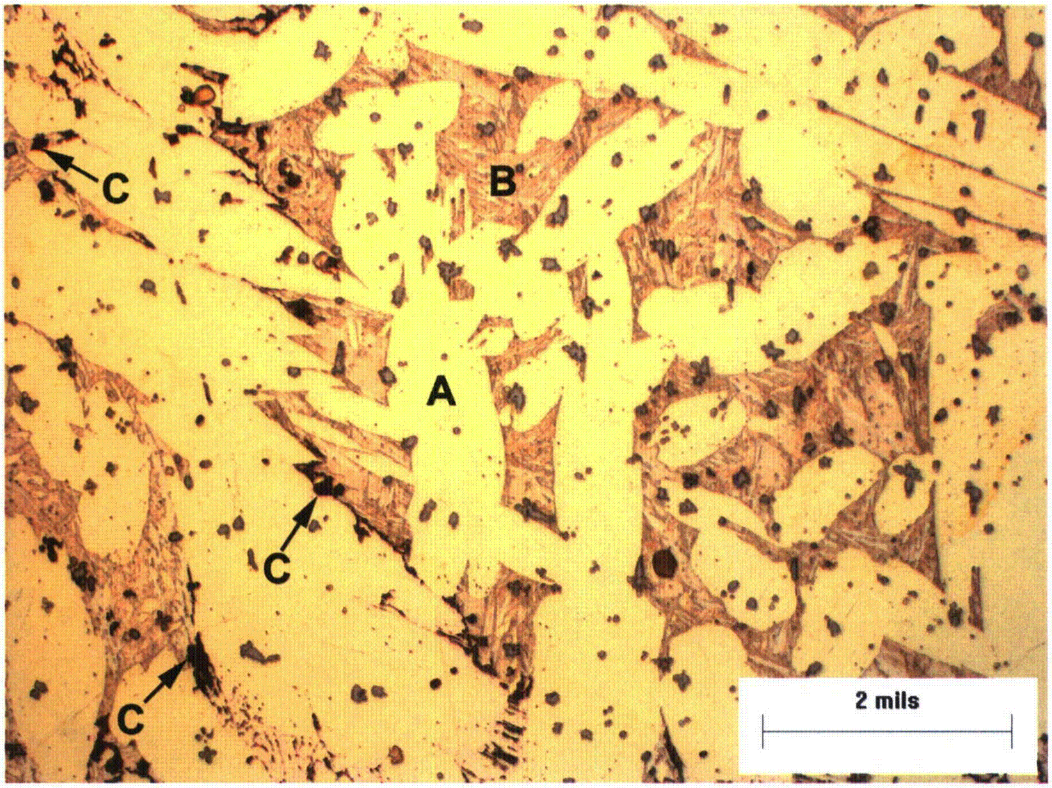
Mount No. 7043 Valve EW315

CA954

From the previous micrographs, it is evident that cast aluminum bronze material used at STP has alpha plus beta and gamma 2 phases that have dealloyed at varying degrees. Some iron rosettes are also present and could have been corroded.

Sample cross-sectional testing performed in 2012 (results provided below) demonstrate that the metallurgical phases are essentially the same as those analyzed early in plant life. The CMTRs for the recently tested material indicated ratios of ultimate tensile strength to yield strength of 2.2 and 2.3. Both mechanical property values exceeded the code specified values by more than 12%. This indicates that the use of code minimum properties in the integrity analyses described in the response to RAI Item b., that follows, is conservative because the material supplied to STP exceeds the Code minimum requirements.

A micrograph of cross sectional testing of material from centrifugal-cast aluminum bronze piping removed from service in 2012 after being in service since initial operation of the ECW system is provided below.



The microstructure comprises a copper-rich alpha matrix (A) along with an alpha-gamma 2 eutectoid (B). Also present are isolated, preferentially attacked gamma-2 – dark regions within the eutectoid and along the grain boundaries (C). These attacked regions are rich in copper.

The above micrograph indicates the presence of the same metallurgical phases as observed in the sections taken from material in 1988.

Table A-3 provides the CMTR data of the mechanical properties for centrifugal-cast aluminum bronze piping material samples.

Table A-3

Heat	Tensile Strength (σ_{TS}), ksi	Yield Strength (σ_{YS}), ksi	σ_{TS}/σ_Y
24899	84.2	39.1	2.2
24900	85.2	36.3	2.3

Table A-3 confirms that the assumed ratio of ultimate tensile strength (UTS) to yield strength (YS) of 2.0 (see responses to RAI Item b.) is appropriate for the aluminum bronze materials at STP. The measured properties are higher than the Code minimum requirements (i.e., ASTM B 148 - Alloy 954, UTS 75 ksi minimum and YS 30ksi minimum) providing additional strength margin.

Aluminum bronze alloys that contain less than 8.5% aluminum consist of single phase (alpha) that is not susceptible to dealloying. Alloys with aluminum content ranging between 8.5 percent and 9.5 percent represent a transition range before the onset of gamma-2 phase formation. Any gamma-2 that may precipitate out in this range would not form a continuous network that would promote through-wall dealloying.

The aluminum bronze alloys with aluminum content exceeding 9.5% are susceptible to dealloying and have mainly alpha, beta, and gamma-2 phases. These phases can also exist in combinations such as alpha plus beta and/or beta plus gamma-2 under certain circumstances. The gamma-2 phase is susceptible to dealloying. The beta phase is anodic to the alpha phase and forms a continuous network providing a continuous path of low corrosion resistance which can penetrate deeply into the alloy. Dealloying may have resulted in selective leaching of the principal alloying element (in this case aluminum) from one phase (mainly gamma) of the alloy leaving a residue of porous copper which retains the original shape and dimensions of the component but has lower strength. By controlling the composition and, for the alloys of high aluminum content, the cooling rate from casting or working temperature, metallurgical structures are ensured that will not experience dealloying to any significant extent under any normal conditions of use.

STP established the ultimate tensile strength of the dealloyed aluminum bronze material in the Essential Cooling Water (ECW) System to be 30 ksi by testing several samples of varying range of aluminum composition. STP will test additional samples that determine yield strength of aluminum bronze cast materials. See response to RAI Items b, d and g below.

NRC RAI

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.

STPNOC Response

- The microstructure for ASME SB-148 CA952 and CA954 as-cast and annealed material normally consists of approximately 50% alpha and 50% metastable beta. Under some conditions, eutectoid decomposition could produce an alpha-gamma-2 structure instead of beta phase. The microstructure for C95200 as-cast is mainly face centered cubic (FCC) alpha with precipitates of iron rich alpha in the form of rosettes and spheres. Depending on the cooling rate, small amount of metastable center phased hexadron (CPH) beta or alpha-gamma eutectoid decomposition products can be present. These different phases can be distinguished under a microscope when the alloy is polished and etched. The phases present in an alloy, along with the overall grain arrangements and grain boundaries, combine to make up an alloy microstructure. The microstructure of an alloy is critical being largely responsible for both the physical and mechanical properties of that alloy.

  The continuous gamma-2 phase (generally present when aluminum content exceeds 9.0%) appears to selectively leach out in a relatively short period of time. This is evident as a large population of STP components dealloyed during the first four to five years of plant operation. The semi-continuous gamma-2 phase (generally present when aluminum ranges from 8.5% to 9.5%) may selectively leach out over a longer period. Weld repairs to castings represent cases where dealloying may still be occurring. Isolated gamma-2 phase is believed to be good for corrosion resistance. It is not feasible to predict material properties because of variability in microstructure and phase formed at the time of fabrication. However, a reasonable assurance for structural integrity can be established through testing. STP had established material properties via testing of the dealloyed aluminum bronze when dealloying was first identified. The ultimate tensile strength was measured for 100% dealloyed material using standard tensile test methodology.

  The ultimate tensile strength of the dealloyed material is used to calculate load carrying capacity reduction factors for the dealloyed components. For 100% dealloyed material, the calculated load carrying capacity reduction factor is 66 percent. It is reasonable to assume a yield stress of 15 ksi since these materials usually have an ultimate tensile strength to yield strength ratio of 2.0. With this assumption, the calculated flow stress is 22.5 ksi, and the load carrying capacity reduction factor for 100% dealloyed material will still be 50 percent. This reduction factor further reduces to 33 percent when recalculated using flow stress of 15 ksi (assumes yield strength as 0 ksi). Note that even with above assumption, components still have adequate load carrying capacity. For ASME Section III Code evaluation purposes, STP has lowered Code allowable stress value to 7.5 ksi (1/4 of ultimate tensile strength of 100% dealloyed material).

- In 1988, STP established the ultimate tensile strength of the dealloyed aluminum bronze material in the ECW System to be 30 ksi by testing several samples of varying range of aluminum composition. Two of the test coupons were 100% dealloyed specimens. STP has no record of measuring the yield strength of dealloyed aluminum bronze material. STP acknowledges that additional aluminum may leach out of material over the life of the dealloyed component.

  In order to justify why the tensile strength described in a tensile test conducted in 1988 will apply to inservice components during the period of extended operation, STP will conduct additional tensile tests of dealloyed aluminum bronze material exposed to ECW System raw water environment. Details of this testing are provided in the response to RAI Items d and g.

- The ultimate tensile strength of the dealloyed material tested early in plant life was measured for 100% dealloyed material using standard tensile test methodology. No record of measuring the yield strength has been found.

NRC RAI

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 30 ksi 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.

STPNOC Response

The process by which dealloying occurs in aluminum bronze is complex. The dealloying process requires not only a susceptible microstructure, but a suitable environment. The optimum environment for dealloying is to have local stagnant conditions and/or crevice geometries. For small bore castings, the gaps at socket-end connections between pipe and fittings or valves create stagnant flow areas and/or crevice geometries that promote dealloying. Stagnant flow conditions can also result from local buildup of surface deposits on the inside surface of the pipe. More typically, a natural stagnant crevice location exists at weld backing rings that remain at some weld locations in large castings and at pipe welds. Most dealloyed locations for large bore castings and welds are associated with weld backing rings. The electrochemistry of the metal within a crevice is acidic – a condition that promotes dealloying.

Through-wall leakage/seepage is caused by the progression of dealloying through the wall. Leakage can be due to dealloying only, or by a combination of dealloying and crack propagation. In most cases, cracking initiates at pre-existing weld flaws and imperfections typically at the weld root or heat-affected zone under the backing ring.

The backing ring and initial weld flaw geometry create a severe environment conducive to the initiation and extension of dealloying. This dealloying mechanism is common to a range of cast aluminum bronze components. In addition, selective dealloying has been observed in welds and weld repair regions of castings, extruded tees, socket weld adaptors and valves. The mechanism for crack extension is believed to be continued dealloying along the crack front which drives the crack subcritically through the wall by the combination of reduction in toughness at the crack tip, service, and weld residual stress. Since the weld residual stresses are in equilibrium through the wall thickness (tensile stresses balanced by compressive stresses), cracks tend to arrest with leaks resulting from through-wall dealloying. This mechanism is not typical of stress corrosion cracking, but instead is more like a local fracture initiation and arrest process.

The number of dealloyed components was reported to the Nuclear Regulatory Commission in 1988 (Reference 1 - see Attachment A to this Enclosure). A typical seepage through cast components was mainly due to porosity caused by dealloyed aluminum bronze castings. There were flaws in the heat affected zone of flange-to-pipe welds that had crack-type appearances. Destructive examinations were not performed for all cases. Therefore, it cannot be concluded whether the root cause of the flaw was due to dealloying or other crack mechanisms. The dealloyed components have been replaced with wrought aluminum bronze components that have not dealloyed. It is not practical to identify all weld repairs on vendor-supplied valves and other aluminum bronze cast components. These components may continue dealloying at weld-repaired areas.

STP has not experienced any catastrophic failures of ECW System components due to dealloying. Operating experience supported by test data demonstrates that when a 100% dealloyed component develops through-wall leakage, sufficient material strength remains in the component allowing replacement at the first available opportunity. The calculated load capacity determined by lower bound values from limit load analysis based on ultimate tensile strength, as discussed in the response to Item b above, and fracture analysis using conservative toughness estimates provide reasonable assurance that the component will remain functional and operable until repair or replacement occurs.

NRC RAI

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.
  - 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.

STPNOC Response

STP proposes the following to validate the structural integrity of the aluminum bronze components.

Structural integrity analyses will be updated and testing will be conducted to confirm that methodologies and assumptions based on past testing remain valid. Six samples from three aluminum bronze components removed from service will be tested to confirm mechanical properties of the material and to confirm extent of dealloying. The aluminum bronze samples exposed to ECW system raw water environment will come from a pump shaft line casing pipe and from two small cast valve bodies. The pump shaft line casing pipe was removed from service in 2012 and the two small cast valve bodies will be removed from service in 2012. The sample components have been exposed to ECW system raw water environment since the ECW System entered service.

The original five tests of dealloyed material (Reference 1 – See Attachment A to this Enclosure) will be complemented by the additional six samples. Since only two of the original samples tested (i.e., those samples that exhibited 100% dealloying) were used to establish tensile strength of the ECW System aluminum bronze component material, priority will be given to selecting samples from 100% dealloyed material. The American Society for Testing and Materials (ASTM) generally requires one test per lot (a lot is usually a single melt or ladle) for characterizing the mechanical properties of aluminum bronze castings (Reference 2 – See Attachment A to this Enclosure). Therefore, testing of six more samples is sufficient to validate the material properties of the material.

The six samples will be tested for chemical composition including aluminum content,

mechanical properties (such as yield and ultimate tensile strengths) and microstructure. Structural integrity analyses will be updated, as required, using the test results from six tests. The schedule for completing these six tests and any required updating the structural integrity analyses is the end of December 2012.

The results of the testing and any required changes to the structural integrity analyses will be completed and submitted to the NRC staff for review by December 2012.

A description of the program to demonstrate structural integrity through the period of extended operation is provided in the response to RAI Item g.

LRA Table A4-1 is revised to add new regulatory commitment 44 for the testing, by the end of December 2012, of six samples from three aluminum bronze components recently removed from service.

New LRA Commitment 44 is provided in Enclosure 3.

NRC 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.

<u>STPNOC Response</u>

The results of metallurgical examinations on eight flanges were used to establish bounding through-wall flaw sizes when only OD measurements are available from leaking components. The through-wall crack defines the dimensions of any cracks that initiated in the dealloyed material and extended through-wall. Through-wall cracks for flanges are in the weld neck areas of the flanges. The welds that join pipes to flanges have their thickness similar to the weld thickness of pipe to pipe welds. Also, dealloying is observed in the heat affected zones of the welds. Thus, the crack size data used for

developing a flaw size correlation curve are based on wall thicknesses rather than flange sizes. This is evident from the correlation curve as the curve reflects the potential for a large amount of average through-wall degradation when short cracks are observed on the outside diameter. This is also observed during metallurgical studies. The sample had relatively large number of 6" and 8" flanges as is evident from Figure G-1 shown in the response to RAI Item g. The dealloyed components identified also have decreasing trend as can been seen from Figure G-3 shown in response to RAI Item g. The correlation curve accounts for potential dealloying of all cracks that estimate conservative crack aspect ratios along the inside diameter for the analytical evaluations.

The data, from seven 6-inch flanges and one 8-inch flange, provide a representative sample size to develop a conservative correlation between outside diameter indications and average degradation length through the wall of the component.

To provide the generic analysis methodology for evaluating dealloyed large bore castings, Aptech report AES-C-1964-1 (Reference 4 - see Attachment A to this Enclosure) was prepared that gives the critical bending stress (σ_b^c) as a function of through-wall flaw length for the various pipe sizes. Both limit load and fracture failure modes were evaluated and the limiting value is used to determine flaw acceptance. These critical bending stress curves are conservatively based on design pressure and lower bound estimates for flow stress and fracture toughness and represent the bending load capacity of a degraded casting with no imposed structural factor (SF). This was intentionally done since the Code SFs are different for different stress classifications and service levels. The critical bending stress curves allow for a generic evaluation and the SFs are applied directly to the applied stresses when comparing to the critical bending stress. In this format, acceptance of a degraded casting is based on the ASME Section XI margin requirement on primary bending as

$$SF = \frac{(\sigma_b^c - \sigma_e + \sigma_m)}{(\sigma_m + \sigma_b)}$$

where σ_e is the applied expansion stress, σ_m is the applied primary membrane stress, and σ_b is the applied primary bending stress at the location of the casting. The calculated SF from the above equation, either limit load or fracture failure modes, can be compared with the ASME Section XI margin requirements of SF $\geq$ 2.77 for normal/upset conditions and SF $\geq$ 1.39 for emergency/faulted conditions.

In practice, the through-wall flaw characteristics (i.e., planar or non-planar) may be such that it is difficult to discern whether there are cracks associated with the through-wall flaw. Therefore, no credit is taken for the strength of dealloyed material and the through-wall portion of the flaw is assumed to be a crack. Figure 7-1 in AES-C-1964-1 is generally not used.

The main purpose of the APTECH report AES-C-1964-5 (Reference 3 - see Attachment A to this Enclosure) is to evaluate the impact of part-through and through-wall dealloying, and subsurface cracks on the through-wall evaluation method for critical bending stress determination. This calculation was created to support the integrity

analysis of AES-C-1964-1 which provides the procedure for establishing margins on detected through-wall dealloying observed along the outside diameter (OD) surface. At the time when AES-C-1964-1 was prepared in 1994, the seven 6-inch and one 8-inch flanges were selected to form a statistical sample to represent the primary parameters for flaw evaluation based on visual examination of the OD surface. The data from these eight flanges indicate that part-through-wall dealloying is most likely present and part-through-wall and/or through-wall cracks may exist.

The profiling of flaw size at inside surfaces is not practical while component is still in service. The sample selection thus was based on flanges that represent the following conditions: (1) through-wall dealloying – with no assumed flaws; (2) part through-wall flaw with dealloying; and (3) through-wall flaw with dealloying. The correlation developed provides a good estimate for crack sizes at the inside surface for all pipe sizes. More prevalent cases of dealloyed components are spots identified at outside surfaces. This is indicative that only part of the total circumference gets dealloyed 100 percent through-wall thickness before through-wall leak appears at the outside surfaces.

Subsequent calculations and the results from the flange bend test indicate that the method of determining the critical bending stress and allowable margins is sufficiently conservative to compensate for the presence of subsurface degradation that can not be observed by visual examination on the OD surface. In 1995, the eight flanges were evaluated to the analysis procedures of AES-C-1964-1 to establish the available margins against failure at the time the flanges were replaced due to leakage. The through-wall crack length used the as-measured inside diameter (ID) and OD lengths to determine an average length for analysis purposes. To determine the available margins, the stresses for each flange were extracted from the piping design report. The calculated margins for these dealloyed flanges exceeded the ASME Section XI Code required margins imposed by ASME Section XI structural factors for normal/upset and emergency/faulted conditions. The ID and OD lengths are the non-destructive examination (NDE) data used to define the correlation between ID and OD sizes in Figure 4-1 of AES-C-1964-5.

STP uses a correlation for functionality and operability evaluations. Dealloyed components with seepage or leaks are replaced or repaired at the earliest possible opportunity. Theoretical estimations of the inside surface flaw sizes for dealloyed seepage conditions are adequate for continued operation of degraded components until they can be replaced at the first available opportunity. For conditions exhibiting measurable leakages, remedial measures such as more frequent field inspections and establishing leak rate limits are implemented.

ASME Code Section XI guidelines are used for grouping multiple flaws where external leakage is characterized by multiple pinpoints or larger indications. These guidelines are applicable for both outside and inside surface flaws. The difference for inside surface flaws is that they are extended prior to grouping per guidelines established in the Aptech calculations discussed above.

ECW System components that exhibit through-wall seepage are repaired or replaced as soon as practical. Operability determinations for evaluating whether a component

with a detectable flaw will continue to meet its intended function are based on an analysis that conservatively assumes the flaw is initiated by a crack. There is no qualified ultrasonic (UT) method to detect de-alloying. UT volumetric examination can only detect linear cracks and is limited to special surface preparations and component geometric configurations, thus limiting its usefulness. Accuracy of volumetric examinations is bounded by analytical assumptions in the analysis for flaw dimensions. There is no benefit to performing volumetric examinations in the Selective Leaching of Aluminum Bronze aging management program (B2.1.37).

NRC RAI

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.

STPNOC Response

The root cause of the cracking mechanism which occurred downstream of butterfly valves was wall thinning by a cavitation mechanism due to throttling valve operation. Metallographic examination did not reveal any evidence of dealloying corrosion or micro-segregation in the weld, heat affected zone, or base metal. All six outside diameter initiated, circumferential fatigue cracks and one inside diameter initiated axial fatigue crack were the secondary cracks that resulted from through-wall cavitation. There was no evidence of manufacturing defects involved in the failure. The laboratory examination report concluded that the fatigue cracking would not have occurred if there were no wall thinning penetration caused by cavitation erosion. Therefore, Table 1 of RAI Response B2.1.37-1 is not updated.

NRC RAI

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.

STPNOC Response

The following figures show some of the data that STP has collected over the years regarding the ECW system failures. The important points regarding these plots are as follows:

- The overall failure rate has declined since discovery of dealloying in 1987.
- The highest numbers of failures occurred early in the life of the plant, representing the infant mortality part of a bathtub curve.
- The failure rate suggests that the most susceptible components have already failed.
- The declining trend in the number of failures is due in part to a decrease in the at- risk population of cast components after they were replaced with wrought aluminum bronze material in 1990.

Figure G-1

Number of Failures vs Components
(Note: Numbers on x-axis refer to piping diameter size)

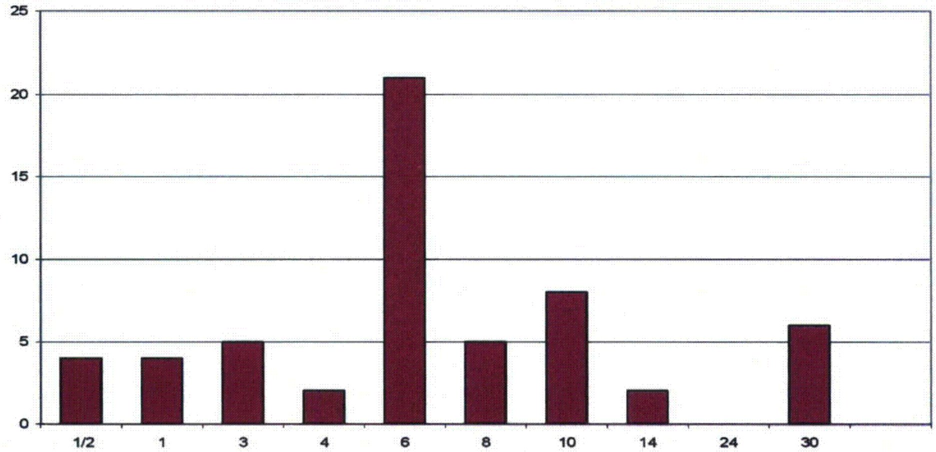


Figure G-2

Number of Component Failures vs Time in Service

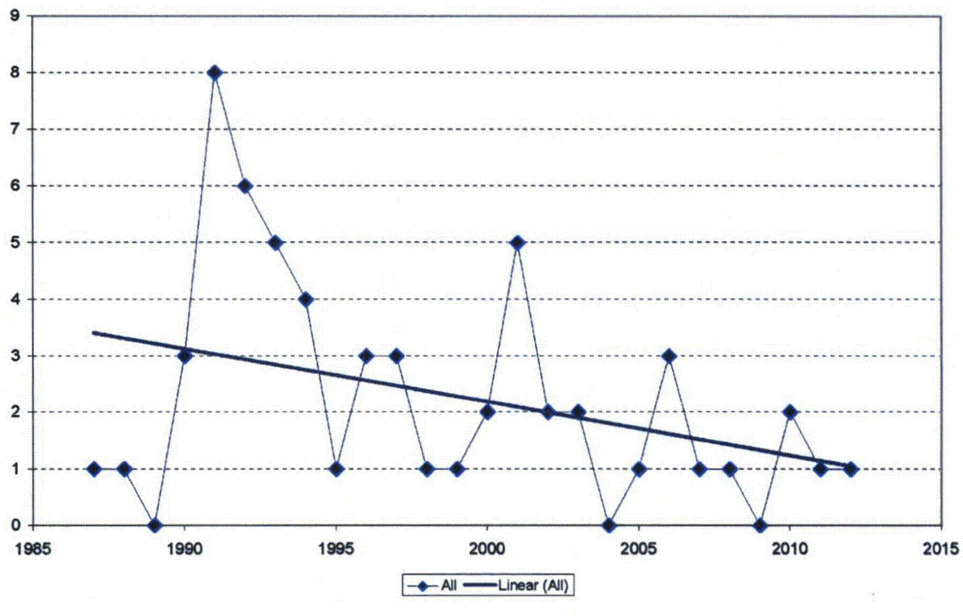
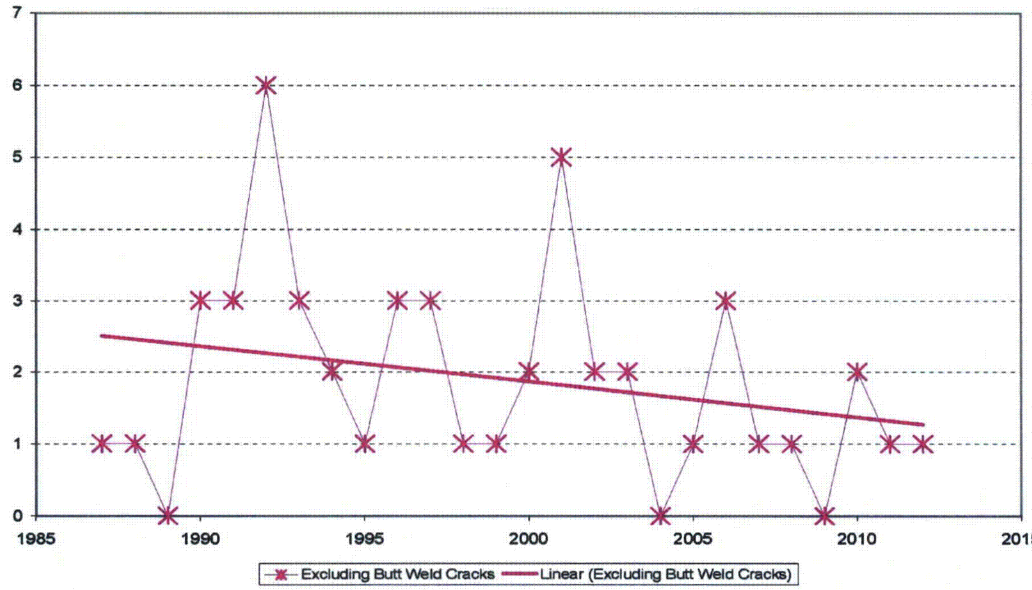


Figure G-3

Through-Wall Indications (Excluding Butt-Weld Cracks) by Year of Discovery



- Periodic metallurgical testing will be performed to confirm that the load carrying capacity of aged dealloyed aluminum bronze material in the ECW System remains adequate to support the intended function of the system during the period of extended operation. Above ground ECW System components removed from service will be tested. For each 10 year interval beginning 10 years prior to the period of extended operation, 20 percent of leaking components removed from service, but at least one, will be tested every five years. Tensile test samples from a removed component will be tested to include both leaking and non-leaking portions of the component. If at least two leaking components are not identified two years prior to the end of each 10-year testing interval, a risk-rank approach based on those components most susceptible to degradation will be used to identify candidate components for removal and testing so at least two components are tested during the 10-year interval. The component will be sectioned to size the inside surface flaws, if present, and/or to map the dealloyed surface areas for determining the extent of the dealloying. The samples will be tested for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. An engineering evaluation will be performed at the end of each testing interval to determine if the sample size requires adjustment based on the results of the tests. The structural integrity analyses will be updated, as required, to validate the assumptions used.

  LRA Appendix A1.37, Appendix B2.1.37, and Table A4-1 Item 39 are revised to include this testing as part of the aging management program for aluminum bronze components.

- For piping below ground, STP will continue the existing monitoring plan for the following reasons.

  Per the ECW System pipe CMTRs, aluminum content ranges between 6.16 percent and 7.96 percent with minimum iron content of 2.2 percent. Aluminum content for pipe fittings are also within this range. The CMTRs for the weld filler material, E/ER Cu A1-A2, show aluminum content between 9.06 percent to 9.55 percent, and minimum iron content between 0.6 and 0.8 percent. During welding of the initial pass on aluminum bronze pipe and fittings (either circumferential or longitudinal), the resulting weld deposit conservatively consists of 70 percent weld filler and 30 percent base material. Using these percentages and applying them to the highest aluminum content and the lowest iron percentage stated above, a weld deposit of 9.07 percent aluminum and 1.08 percent iron is obtained. For joints with aluminum bronze backing strip, the base metal percentage would be higher. Consequently, the aluminum percentage would be lower and the iron content would be higher. A 9.1 percent aluminum content alloy requires the weld to be in the 400°C to 900°C temperature range for seven minutes for gamma-2 phase to form. This is not likely because of rapid heat loss to air and along the length of the pipe. Thus, the deleterious gamma-2 phase will not have time to form a continuous network. Subsequent weld passes will not increase the aluminum percentage of the initial weld pass material and will not result in the initial weld pass material being in the temperature range of 400°C to 900°C long enough for gamma-2 phase to form. The below ground piping is monitored on at least a semi-annual basis by a walkdown of the ground above. A leak rate of ten gallons per minute or larger will eventually result in water seepage or springs at the ground surface.

  The ECW system is part of the buried pipe inspection program. If a leak from below-grade welds is discovered by surface water monitoring or during a buried ECW System piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination.

- As stated in item d, recently removed components will be tested to evaluate aging impact due to the continual exposure to operating environment. Additionally, as stated above, samples of components removed from service will be tested every 10 years.

- The destructive testing proposed in the response to items d and g will provide an accurate validation of the aluminum bronze component structural integrity. Due to the limitation of performing volumetric examinations on aluminum bronze material as stated in the response to Item e above, STP does not propose to perform volumetric examinations.

- Enclosure 2 provides the line-in/line-out revision to LRA Appendices A1.37 and B2.1.37. Enclosure 3 provides the line-in/line-out revision to LRA Commitment 39.

<u>NRC RAI</u>

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.

STPNOC Response

True critical crack size, in the context of fracture mechanics, is dependent on pipe stress. A relatively small crack may be critical in a highly stressed pipe, but that same crack may be less-than-critical in pipe locations subjected to lower stresses.

The "critical" flaw size mentioned in UFSAR Appendix 9A is not a true critical flaw size. The opening size is established as a rectangle one-half the pipe diameter by one-half the pipe thickness per Branch Technical Position ASB 3-1 regardless of the loading on the pipe. This calculated opening size is used for flooding analysis. Although referred to as a critical flaw size, it is different from a true critical crack length established by fracture mechanics.

Thus the crack size used for the design-basis flooding analysis differs from the critical crack size determined from fracture mechanics. The methodology for the flooding analysis is described in the UFSAR. The basis for this methodology includes Branch Technical Positions ASB 3-1 and MEB 3-1 which are listed as references in UFSAR Appendix 9A. The flooding analysis for a particular room determines the flood water input rate by using the maximum flow rate from among the flows determined from a postulated crack in each pipe in the room. This is used to establish the design-basis flood heights for each area of the particular building. These flood heights are used in an evaluation of potentially impacted equipment to show that safe shutdown capability is maintained.

The operability evaluation of a condition of a flaw in the piping (or component) includes:

- Flooding analysis - Comparison of the leak rate due to the flaw to the design basis flooding analysis (which is based upon a crack size for a pipe in the particular room as described above).

- Functional flow requirements - Comparison of the leak rate due to the flaw to the functional requirements for flow rate of the affected component.

- Structural integrity - Comparison of the flaw to the critical crack size determined from fracture mechanics for the structural integrity evaluation.

When analyzing the impact of flooding, reduction in flow, and water loss from the essential cooling pond, the cumulative impact of multiple through-wall flaws is considered for the operability evaluation of the ECW system. The total leakage rate is considered. If it occurs through multiple wall flaws, the combined total leakage rate is evaluated. Compensatory actions are taken as necessary to maintain operability if the flaws are not repaired within the allotted time frame.

ECW system leakage associated with dealloying is a slowly developing process. Above ground leaks would be detected almost immediately and would not be allowed to progress to the medium energy break size flaw assumed in the flooding analysis or progress to the critical crack size that could compromise structural integrity of the pipe.

NRC RAI

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.

STPNOC Response

The ultimate tensile strength results from the metallurgical aluminum bronze material testing described in the response to RAI Items d and g will be monitored and trended. Monitoring provides trending of the ultimate tensile strength for aging aluminum bronze material through the period of extended operation. Upon completion of each test, the data trended is evaluated against the acceptance criteria for ultimate tensile strength.

The acceptance criterion for ultimate tensile strength of aluminum bronze material is an averaged value greater than or equal to 30 ksi. If the criterion is not met, the condition is documented in the corrective action program to perform a structural integrity analysis to confirm that the load carrying capacity of the tested material remains adequate to support the intended function of the ECW system through the period of extended operation.

NRC RAI

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

STPNOC Response

Attachment B to this Enclosure provides the document titled "ECW Dealloying and Weld Crack Data Tables Clarification Aluminum – Bronze RAI Response (Tables)" that is posted on the South Texas Project License Renewal Application Online Reference Portal.

Attachment A

List of References

List of References

1. Letter dated November 1, 1988 from M. A. McBurnett, Houston Lighting & Power, to the NRC Document Control Desk, "Status of Corrective Actions in the ECW System," (ST-HL-AE-2748)

2. ASTM B824-11, "Standard Specification for General Requirements of Copper Alloy Castings"

3. AES-C-1964-5, "Evaluation of the Significance of Dealloying and Subsurface Cracks on Flaw Evaluation Method," December 23, 1994.

4. AES-C-1964-1, "Calculation of Critical Bending Stress for Dealloyed Aluminum bronze Castings in the ECW System," January 21, 1994.

Attachment B

"ECW Dealloying and Weld Crack Data Tables Clarification Aluminum – Bronze RAI Response (Tables)"

**RESPONSE TO TELECONFERENCE QUESTION
BETWEEN THE NRC AND STPNOC
January 10, 2012**

Reference: STPNOC letter dated December 8, 2011, from D. W. Rencurrel to NRC Document Control Desk, "Supplement to the South Texas Project License Renewal Application Aging Management Program, Set 8 (TAC Nos. ME4936 and ME 4937)" (NOC-AE-11002766) (ML11354A087)

NRC Question

As noted during the conference call, verify or clarify as to whether staff understanding of the following is as stated...

Results of staff review of Tables 1 and 2 in the RAI B2.1.37-1 response:

i. Staff infers from Table 2 that 1994 was the last year where a classic dealloy/weld crack phenomenon occurred, the following entries from Table 1 appear to be weld crack related – please reconcile or explain

1. Item 28, April 23, 1996

2. Item 29, April 24, 1996

3. Item 53, August 19, 2010

ii. Table 2 appears to duplicate some items in Table 1. Are any of the items in Table 1 associated with a weld crack failure except for the following? In other words, with the exception of the below items 3, 10, 11, and 22, are all other items in Table 1 <u>not associated</u> with a weld crack?

4. Item 3 appears to be the same entry as Table 2 Item 1

5. Item 10 appears to be the same entry as Table 2 Item 2

6. Item 11 appears to be the same entry as Table 2 Item 3

7. Item 22 appears to be the same entry as Table 2 Item 8

STPNOC Response

Many of the Table 1 items are associated with dealloying of castings near butt welds. It is important to note that the dealloying is occurring in the metal of the casting, not the weld metal. Castings with backing ring welds are most susceptible to this dealloying. The only occurrences of de-alloyed weld metal are those listed in Table 2 and the specific cases noted below in Table 1. Table 1 Items 15 and 37 are associated with weld metal dealloying in the weld repair of extruded Tees. Extruded Tees are a special case of weld metal dealloying that is not associated with linear indications or cracks. Table 1 Items 21, 24, 25, and 42 are

associated with weld metal dealloying in the socket weld done by the valve manufacturer to add an adapter. This is another special case of weld metal dealloying not associated with linear indications or cracks.

- Table 1 Item 28 is for a crack indication in a cast flange. The crack was in the casting, running parallel to the flange to pipe weld but did not involve dealloying of the weld metal.
- Table 1 Item 29 is for a crack indication in a cast flange. The crack was in the casting, running parallel to the flange to pipe weld but did not involve dealloying of the weld metal.
- Table 1 Items 28 and 29 are very similar indications at the same locations in Unit 1 and Unit 2. The Unit 1 flange was sent out for failure analysis (TR-11078). The report notes that the crack that caused the leak was the result of inter-granular dealloying in the casting at the edge of the heat affected zone of the butt weld. The crack was entirely within the metal of the casting.
- Table 1 Item 53 is for a crack indication in a cast flange. The crack was in the casting, running parallel to the flange to pipe weld but did not involve dealloying of the weld metal.
- Table 1 Item 53 was not analyzed, but the attached pictures show the crack indication and residue deposits in the metal of the casting.
- Table 1 Items 10 and 22 are for weld cracks associated with dealloying.
- Table 1 Items 4 and 5 are associated with cracking and leakage at aluminum bronze to stainless steel welds. This leakage, however, is not associated with aluminum bronze dealloying.
- Table 1 Items 15 and 37 are associated with weld metal dealloying in the weld repair of extruded Tees.

Note that many of the casting dealloying entries are near the weld. This area of the casting is subject to some of the stress and heat effects of welding and many of the casting indications are at welds with backing rings that provide an aggressive crevice condition at the casting. For many of the castings, the area near the weld is also the thinnest part of the casting (for example, a cast weld neck flange).

- Table 1 Item 3 is the same entry as Table 2 Item 1. There was no indication of de-alloyed weld metal; this appears to have been a fabrication flaw.
- Table 1 Item 10 is the same entry as Table 2 Item 2. This is a classic weld crack with dealloying.

- Table 1 Item 11 is for a crack in a cast flange. The crack was in the casting, running parallel to the flange to pipe weld but did not involve dealloying of the weld metal. Table 1 Item 11 is not related to Table 2 Item 3.
- Table 1 Item 22 is for the same entry as Table 2 Item 8. This is a weld crack with dealloying.

Enclosure 2

STPNOC LRA Changes with Line-in/Line-out Annotations

List of Revised LRA Sections

RAI	Affected LRA Section
B2.1.37-3	A1.37
	B2.1.37

A1.37 SELECTIVE LEACHING OF ALUMINUM BRONZE

The Selective Leaching of Aluminum Bronze program manages loss of material due to selective leaching of aluminum bronze (copper alloy with greater than eight percent aluminum) components exposed to raw water within the scope of license renewal. The Selective Leaching of Aluminum Bronze program is an existing program that is implemented by STP procedure. The procedure directs that every six months (not to exceed nine months), an inspection of all aluminum bronze components be completed. STP has buried piping with less than eight percent aluminum content, and that is not susceptible to dealloying. However, there are welds in which the filler metal is a copper alloy with greater than eight percent aluminum material. Therefore, the procedure directs that a yard walkdown be performed above the buried piping with aluminum bronze welds, from the intake structure to the unit and from the unit to the discharge structure to look for changes in ground conditions that would indicate leakage. If a leak from below-grade weld is discovered by surface water monitoring or during a buried ECW piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination. Aluminum bronze (copper alloy with greater than 8 percent aluminum) components which are found to have indications of through-wall dealloying are evaluated, and scheduled for replacement by the corrective action program. Components with indications of through-wall dealloying, associated with piping greater than one inch in diameter, will be replaced by the end of the next refueling outage. ~~Destructive examinations of a sample of through-wall de-alloyed components will be performed to determine the extent of dealloying before and after the period of extended operation.~~

Periodic metallurgical testing of aluminum bronze material components will be performed to update the structural integrity analyses, confirm load carrying capacity, and determine extent of dealloying. Above ground ECW system components removed from service will be tested. For each 10 year interval beginning 10 years prior to the period of extended operation, 20 percent of leaking components removed from service, but at least one, will be tested every five years. Tensile test samples from a removed component will be tested to include both leaking and non-leaking portions of the component. If at least two leaking components are not identified two years prior to the end of each 10-year testing interval, a risk-rank approach based on those components most susceptible to degradation will be used to identify candidate components for removal and testing so at least two components are tested during the 10-year interval. The samples will be tested for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. An engineering evaluation will be performed at the end of each testing interval to determine if the sample size requires adjustment based on the results of the tests. The acceptance criterion for ultimate tensile strength value of aluminum bronze material is an averaged value of greater than or equal to 30 ksi. If the criterion is not met, the condition will be documented in the corrective action program to perform a structural integrity analysis to confirm that the load carrying capacity of the tested material remains adequate to support the intended function of the ECW system through the period of extended operation.

B2.1.37 Selective Leaching of Aluminum Bronze

Program Description

The Selective Leaching of Aluminum Bronze program manages loss of material due to selective leaching for aluminum bronze (copper alloy with greater than eight percent aluminum) components exposed to raw water within the scope of license renewal. This plant-specific program will use requirements of the Selective Leaching of Materials program (B2.1.17) specifically relating to aluminum bronze components. The selective leaching of aluminum bronze is applied in addition to the Open-Cycle Cooling Water program (B2.1.9).

The Selective Leaching of Aluminum Bronze program is an existing program that is implemented by plant procedure. This procedure directs that every six months (not to exceed nine months), an inspection of aluminum bronze (copper alloy with greater than eight percent aluminum) components be completed. STP has buried copper piping with less than eight percent aluminum content that is not susceptible to dealloying. However, there are welds in which the filler metal is copper alloy with greater than eight percent aluminum material. Therefore, the procedure directs that a yard walkdown be performed above the buried piping with aluminum bronze welds, from the intake structure to the unit and from the unit to the discharge structure to look for changes in ground conditions that indicate leakage. Aluminum bronze (copper alloy with greater than 8 percent aluminum) components which are found to have indications of through-wall dealloying are evaluated, and scheduled for replacement by the corrective action program. Components with indications of through-wall dealloying, greater than one inch, will be replaced by the end of the next refueling outage. Periodic destructive examinations of aluminum bronze material components will be performed to update the structural integrity analyses, confirm load carrying capacity, and determine extent of dealloying.

Aging Management Program Elements

The results of an evaluation of each element against the 10 elements described in Appendix A of NUREG-1800, *Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants* are provided below.

Scope of Program (Element 1)

The Selective Leaching of Aluminum Bronze program manages loss of material due to selective leaching for aluminum bronze (copper alloy with greater than eight percent aluminum) pumps, piping welds and valve bodies exposed to raw water within the scope of license renewal. These aluminum bronze (copper alloy with greater than eight percent aluminum) components with raw water internal environments are susceptible to loss of material due to selective leaching (dealloying).

STP has analyzed the effects of dealloying and found that the degradation is slow so that rapid or catastrophic failure is not a consideration. ~~STP has~~ A structural integrity analysis performed when dealloying was first identified confirmed that 100 percent dealloyed aluminum bronze material retains sufficient load carrying capacity. This structural integrity analysis determined that the leakage can be detected before the flaw reaches a limiting size that would affect the

intended functions of the essential cooling water and essential cooling water screen wash system. ~~The prudent course of action is to continue monitoring and replace components when needed.~~

Periodic d~~D~~estructive examinations of aluminum bronze material ~~through-wall de-alloyed~~ components will be performed to ~~determine~~ update the structural integrity analyses, confirm load carrying capacity, and determine the extent of dealloying. ~~If components are identified as leaking during the ten year period prior to the period of extended operation, then a destructive metallurgical examination of one leaking component per unit will be performed. Preference in the selection of the component to be destructively examined will be given to a leaking weld with a backing ring that would be similar to the welds in buried ECW wrought aluminum bronze piping.~~ Six samples from three aluminum bronze components removed from service in 2012 will be tested for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. The aluminum bronze samples exposed to ECW system raw water environment will come from a pump shaft line casing pipe and from two small cast valve bodies. The pump shaft line casing pipe was removed from service in 2012 and the two small cast valve bodies will be removed from service in 2012. The components to be samples have been exposed to ECW system raw water environment since the ECW system entered service. Priority will be given to selecting 100% dealloyed component samples. STP will complete this testing prior to the end of 2012.

Periodic metallurgical testing will be performed to confirm that the load carrying capacity of aged dealloyed aluminum bronze material in the ECW system remains adequate to support the intended function of the system during the period of extended operation. Above ground ECW System components removed from service will be tested. For each 10 year interval beginning 10 years prior to the period of extended operation, 20 percent of leaking components removed from service, but at least one, will be tested every five years. Tensile test samples from a removed component will be tested to include both leaking and non-leaking portions of the component. If at least two leaking components are not identified two years prior to the end of each 10-year testing interval, a risk-rank approach based on those components most susceptible to degradation will be used to identify candidate components for removal and testing so at least two components are tested during the 10-year interval. The component will be sectioned to size the inside surface flaws, if present, and/or mapping of the dealloyed surface areas for determining the extent of the dealloying. The samples will be tested for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. An engineering evaluation will be performed at the end of each testing interval to determine if the sample size requires adjustment based on the results of the tests. The structural integrity analyses will be updated as required to validate adequate load carrying capacity.

~~This~~ Plant procedure directs that every six months (not to exceed nine months)~~,~~ an inspection of all susceptible aluminum bronze (copper alloy with greater than eight percent aluminum) above ground components be completed to identify ~~and~~ any components that show evidence of dealloying ~~will be replaced by the end of the next refueling outage~~. Aluminum bronze (copper alloy with greater than 8 percent aluminum) components which are found to have indications of through-wall dealloying are evaluated, and scheduled for replacement by the corrective action program. Components greater than one inch will be replaced by the end of the subsequent refueling outage. ~~If no leaking components are identified as leaking during the~~

~~ten year period prior to the period of extended operation, destructive examination will be performed on the current inventory of leaking components that were removed from service prior to this period.~~

STP has buried copper alloy piping with less than eight percent aluminum that is not susceptible to dealloying. However, there are welds in which the filler metal is copper alloy with greater than eight percent aluminum material. Therefore, the procedure directs that a yard walkdown be performed above the buried piping aluminum bronze welds, from the intake structure to the unit and from the unit to the discharge structure to look for changes in ground conditions that indicate leakage. ~~Aluminum bronze (copper alloy with greater than 8 percent aluminum) components which are found to have indications of through-wall dealloying are evaluated, and scheduled for replacement by the corrective action program.~~ If leaking below-grade welds are discovered by surface water monitoring or during a buried ECW piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination.

~~Components, greater than one inch, will be replaced by the end of the next refueling outage.~~

~~If components leak during the period of extended operation, up to an additional four leaking components (i.e. two per unit) will be destructively examined during the period of extended operation, if through-wall leaks are observed.~~

Preventive Actions (Element 2)

The Selective Leaching of Aluminum Bronze program does not prevent degradation due to aging effects but provides for inspections to detect aging degradation prior to the loss of intended functions, replacement of degraded components, and testing to confirm load carrying capacity of aged dealloyed aluminum bronze material .

The Open-Cycle Cooling Water program (B2.1.9) uses an oxidizing biocide treatment (sodium hypochlorite and sodium bromide) to reduce the potential for microbiologically influenced corrosion.

Parameters Monitored or Inspected (Element 3)

The Selective Leaching of Aluminum Bronze program includes visual inspections every six months (not to exceed nine months) for dealloying in all susceptible aluminum bronze (copper alloy with greater than eight percent aluminum) components. During these inspections, if evidence of through-wall dealloying is discovered, the components are evaluated and scheduled for replacement by the corrective action program. Components, greater than one inch, will be replaced by the end of the next refueling outage.

During the walkdown of the buried essential cooling water piping, the ground is observed for conditions that would indicate leakage due to selective leaching. Whenever aluminum bronze materials are exposed during inspection of the buried essential cooling water piping, the components are examined for indications of selective leaching. If leaking below-grade welds are discovered by surface water monitoring or during a buried ECW piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination.

Detection of Aging Effects (Element 4)

The Selective Leaching of Aluminum Bronze program includes visual inspection of aluminum bronze (copper alloy with greater than eight percent aluminum) components to determine if selective leaching of these components is occurring. Every six months (not to exceed nine months), an inspection of susceptible above ground aluminum bronze (copper alloy with greater than eight percent aluminum) components is completed to identify any components that show evidence of dealloying. Every 6 months, a walkdown is performed above the buried essential cooling water piping containing copper alloy welds with an Aluminum content greater than 8 percent. During the walkdown, the soil is observed to identify conditions that may be an indication of leakage due to selective leaching. Whenever aluminum bronze materials are exposed during inspection of the buried essential cooling water and ECW screen wash system piping, the components are examined for indications of selective leaching. If leaking below-grade welds are discovered by surface water monitoring or during a buried ECW piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination.

Aluminum bronze (copper alloy with greater than 8 percent aluminum) components which are found to have indications of through-wall dealloying are evaluated, and scheduled for replacement by the corrective action program. Components, greater than one inch, will be replaced by the end of the next refueling outage. ~~If components are identified as leaking during the ten year period prior to the period of extended operation, then a destructive metallurgical examination of one leaking component per unit will be performed. Preference in the selection of the component to be destructively examined will be given to a leaking weld with a backing ring that would be similar to the welds in buried ECW wrought aluminum bronze piping. If components leak during the period of extended operation, up to an additional four leaking components (i.e. two per unit) will be destructively examined during the period of extended operation, if through-wall leaks are observed. If no leaking components are identified as leaking during the ten year period prior to the period of extended operation, destructive examination will be performed on the current inventory of leaking components that were removed from service prior to this period.~~

Periodic destructive examinations of aluminum bronze material components will be performed to update the structural integrity analyses, confirm load carrying capacity, and determine extent of dealloying. Six samples from three aluminum bronze components removed from service in 2012 will be tested for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. The aluminum bronze samples exposed to ECW system raw water environment will come from a pump shaft line casing pipe and from two small cast valve bodies. The pump shaft line casing pipe was removed from service in 2012 and the two small cast valve bodies will be removed from service in 2012. The sample components have been exposed to ECW system raw water environment since the ECW system entered service. Priority will be given to selecting 100% dealloyed component samples. STP will complete this testing prior to the end of 2012.

Periodic metallurgical testing will be performed to confirm that the load carrying capacity of aged dealloyed aluminum bronze material in the ECW system remains adequate to support the intended function of the system during the period of extended operation. Above ground ECW system components removed from service will be tested. For each 10 year interval

beginning 10 years prior to the period of extended operation, 20 percent of leaking components removed from service, but at least one, will be tested every five years. Tensile test samples from a removed component will be tested to include both leaking and non-leaking portions of the component. If at least two leaking components are not identified two years prior to the end of each 10-year testing interval, a risk-rank approach based on those components most susceptible to degradation will be used to identify candidate components for removal and testing so at least two components are tested during the 10-year interval. The component will be sectioned to size the inside surface flaws, if present, and/or to map the dealloyed surface areas for determining the extent of the dealloying. The samples will be tested for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. An engineering evaluation will be performed at the end of each testing interval to determine if the sample size requires adjustment based on the results of the tests. The structural integrity analyses will be updated as required to validate adequate load carrying capacity.

Monitoring and Trending (Element 5)

The ultimate tensile strength results from the metallurgical aluminum bronze material testing will be monitored and trended. Trending provides monitoring of the ultimate tensile strength for aging aluminum bronze material through the period of extended operation. Upon completion of each test, the data trended will be evaluated against the acceptance criteria for ultimate tensile strength. ~~There is no monitoring and trending for the visual inspections of aluminum bronze components.~~

Acceptance Criteria (Element 6)

Dealloying of aluminum bronze components is a well known phenomenon at STP. A long term improvement plan was developed in May 1992. As a result of these analyses, aluminum bronze (copper alloys with greater than eight percent aluminum) components are visually inspected every six months (not to exceed nine months). Upon discovery of visual evidence of through-wall dealloying, components are evaluated, and scheduled for replacement by the corrective action program. Components, greater than one inch, will be replaced by the end of the next refueling outage. Due to the slow nature of dealloying, this replacement interval provides reasonable assurance that the systems and components within the scope of this program will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation.

The acceptance criterion for ultimate tensile strength value of aluminum bronze material is an averaged value of greater than or equal to 30 ksi. If the criterion is not met, the condition will be documented in the corrective action program to perform a structural integrity analysis to confirm that the load carrying capacity of the tested material remains adequate to support the intended function of the ECW System through the period of extended operation.

Corrective Actions (Element 7)

STP site QA procedures, review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR 50 Appendix B and are acceptable in addressing corrective actions. The QA program includes elements of corrective

action, and is applicable to the safety-related and nonsafety-related systems, structures and components that are subject to aging management review.

Confirmation Process (Element 8)

STP site QA procedures, review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR 50 Appendix B and are acceptable in addressing confirmation processes and administrative controls. The QA program includes elements of corrective action, and is applicable to the safety-related and nonsafety-related systems, structures and components that are subject to aging management review.

Administrative Controls (Element 9)

See Element 8.

Operating Experience (Element 10)

A review of the STP plant-specific operating experience indicates that macrofouling, general corrosion, erosion-corrosion, and through-wall dealloying have been observed in aluminum bronze components. STP has analyzed the effects of the through-wall dealloying and found that the degradation is slow so that rapid or catastrophic failure is not a consideration. STP has determined that the leakage can be detected before the flaw reaches a limiting size that would affect the intended functions of the essential cooling water and essential cooling water screen wash system. A long range improvement plan and engineering evaluation were developed to deal with the dealloying of aluminum bronze components when dealloying has been identified. Based on these analyses, the approach has been to evaluate components, and schedule replacement by the corrective action program. Components with indications of through wall dealloying, associated with piping greater than one inch in diameter, will be replaced by the end of the next refueling outage. A monitoring and inspection program provides confidence in the ability to detect the leakage.

Enhancements

Prior to the period of extended operation, the following enhancements will be implemented in the following program elements:

Scope of Program (Element 1)

Procedures will be enhanced to: ~~perform destructive examinations of through-wall de-alloyed components to determine the extent of dealloying. If components are identified as leaking during the ten year period prior to the period of extended operation, then a destructive metallurgical examination of one leaking component per unit will be performed. Preference in the selection of the component to be destructively examined will be given to a leaking weld with a backing ring that would be similar to the welds in buried ECW wrought aluminum bronze piping. If no leaking components are identified as leaking during the ten year period prior to the period of extended operation, destructive examination will be performed on the current inventory of leaking components that were removed from service prior to this period. If leaking~~

~~below-grade welds are discovered by surface water monitoring or during a buried ECW piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination. If components leak during the period of extended operation, up to an additional four leaking components (i.e. two per unit) will be destructively examined during the period of extended operation, if through-wall leaks are observed.~~

Perform metallurgical testing of aluminum bronze material components to update the structural integrity analyses, confirm load carrying capacity, and determine the extent of dealloying.

Test six samples from three aluminum bronze components removed from service in 2012 for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. The aluminum bronze test samples exposed to ECW system raw water environment are to come from a pump shaft line casing pipe and from two small cast valve bodies. The pump shaft line casing pipe was removed from service in 2012 and the two small cast valve bodies will be removed from service in 2012. Priority shall be given to selecting 100% dealloyed component samples.

Periodically test samples of above ground ECW system components removed from service for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. For each 10 year interval beginning 10 years prior to the period of extended operation, 20 percent of leaking components removed from service, but at least one, will be tested every five years. Tensile test samples from a removed component shall be tested to include both leaking and non-leaking portions of the component. If at least two leaking components are not identified two years prior to the end of each 10-year testing interval, a risk-rank approach will be used based on those components most susceptible to degradation to identify candidate components for removal and testing so at least two components are tested during the 10-year interval.

Perform an engineering evaluation at the end of each testing interval to determine if the sample size requires adjustment based on the results of the tests.

Specify the acceptance criterion for ultimate tensile strength value of aluminum bronze material is an averaged value of greater than or equal to 30 ksi.

Initiate a corrective action document when the acceptance criterion is not met.

Perform a structural integrity analysis to confirm that the load carrying capacity of the tested material remains adequate to support the intended function of the ECW system through the period of extended operation.

Parameters Monitored and Inspected (Element 3)

Procedures will be enhanced to indicate that whenever aluminum bronze materials are exposed during inspection of the buried essential cooling water piping, the components are examined for indications of selective leaching. If leaking below-grade welds are discovered by

surface water monitoring or during a buried ECW piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination.

Detection of Aging Effects (Element 4)

Procedures will be enhanced to:

Indicate that whenever aluminum bronze materials are exposed during inspection of the buried essential cooling water piping, the components are examined for indications of selective leaching. If leaking below-grade welds are discovered by surface water monitoring or during a buried ECW piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination. ~~If components are identified as leaking during the ten year period prior to the period of extended operation, then a destructive metallurgical examination of one leaking component per unit will be performed. Preference in the selection of the component to be destructively examined will be given to a leaking weld with a backing ring that would be similar to the welds in buried ECW wrought aluminum bronze piping. If components leak during the period of extended operation, up to an additional four leaking components (i.e. two per unit) will be destructively examined during the period of extended operation, if through-wall leaks are observed. If no leaking components are identified as leaking during the ten year period prior to the period of extended operation, destructive examination will be performed on the current inventory of leaking components that were removed from service prior to this period.~~

Perform metallurgical testing of aluminum bronze material components to update the structural integrity analyses, confirm load carrying capacity, and determine the extent of dealloying.

Test six samples from three aluminum bronze components removed from service in 2012 for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. The aluminum bronze test samples exposed to ECW system raw water environment are to come from a pump shaft line casing pipe and from two small cast valve bodies. The pump shaft line casing pipe was removed from service in 2012 and the two small cast valve bodies will be removed from service in 2012. Priority shall be given to selecting 100% dealloyed component samples.

Test samples of above ground ECW system components removed from service for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. For each 10 year interval beginning 10 years prior to the period of extended operation, 20 percent of leaking components removed from service, but at least one, will be tested every five years. Tensile test samples from a removed component shall be tested to include both leaking and non-leaking portions of the component. If at least two leaking components are not identified two years prior to the end of each 10-year testing interval, a risk-rank approach will be used based on those components most susceptible to degradation to identify candidate components for removal and testing so at least two components are tested during the 10-year interval.

Perform an engineering evaluation at the end of each testing interval to determine if the sample size requires adjustment based on the results of the tests.

Specify the acceptance criterion for ultimate tensile strength value of aluminum bronze material is an averaged value of greater than or equal to 30 ksi.

Initiate a corrective action document when the acceptance the criterion is not met.

Perform a structural integrity analysis to confirm that the load carrying capacity of the tested material remains adequate to support the intended function of the ECW system through the period of extended operation.

Conclusion

The continued implementation of the Selective Leaching of Aluminum Bronze program provides reasonable assurance that aging effects will be managed such that the systems and components within the scope of this program will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation.

Enclosure 3

Regulatory Commitments

A4 LICENSE RENEWAL COMMITMENTS

Table A4-1 identifies proposed actions committed to by STPNOC for STP Units 1 and 2 in its License Renewal Application. These and other actions are proposed regulatory commitments. This list will be revised, as necessary, in subsequent amendments to reflect changes resulting from NRC questions and STPNOC responses. STPNOC will utilize the STP commitment tracking system to track regulatory commitments. The Condition Report (CR) number in the Implementation Schedule column of the table is for STPNOC tracking purposes and is not part of the amended LRA.

Table A4-1 License Renewal Commitments

Item #	Commitment	LRA Section	Implementation Schedule
39	Enhance the Selective Leaching of Aluminum Bronze procedures to: • examine aluminum bronze materials exposed during inspection of the buried essential cooling water piping for evidence of selective leaching, • perform periodic metallurgical testing of aluminum bronze material components to update the structural integrity analyses, confirm load carrying capacity, and determine extent of dealloying as follows: o Above ground ECW System components removed from service will be tested as follows: ▪ For each 10 year interval beginning 10 years prior to the period of extended operation, 20 percent of leaking components removed from service, but at least one, will be tested every five years. ▪ Tensile test samples from a removed component will be tested to include both leaking and non-leaking portions of the component. ▪ If at least two leaking components are not identified two years prior to the end of each 10-year testing interval, a risk-rank approach based on those components most susceptible to degradation will be used to identify candidate components for removal and testing so at least two components are tested during the 10-year	B2.1.37	Prior to the period of extended operation CR 11-28986

Table A4-1 License Renewal Commitments

Item #	Commitment	LRA Section	Implementation Schedule
	interval. ▪ The samples will be tested for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. ▪ An engineering evaluation will be performed at the end of each testing interval to determine if the sample size requires adjustment based on the results of the tests. ▪ The acceptance criterion for ultimate tensile strength value of aluminum bronze material is an averaged value of greater than or equal to 30 ksi. ▪ Initiate a corrective action document when the acceptance criterion is not met. • ~~perform destructive examinations of one through-wall de-alloyed component per unit to determine the extent of dealloying if components are identified as leaking during the ten year period prior to the period of extended operation,~~ o ~~give preference in the selection of the component to be destructively examined to a leaking weld with a backing ring that would be similar to the welds in buried ECW wrought aluminum bronze piping. If no leaking components are found during this period, destructive examination will be performed on the current inventory of leaking components that were removed from service prior to this period of extended operation,~~ • ~~perform destructive examinations on up to an additional four leaking components (i.e. two per unit) during the period of extended operation, if through-wall leaks are observed during the period of extended operation~~, and • if a leak from below-grade welds is discovered by surface water monitoring or during a buried ECW piping inspection, a section of each leaking weld will be removed for destructive metallurgical examination.		
44	Structural integrity analyses will be updated and testing will be conducted to confirm that methodologies and assumptions based on past information remain valid. • Six samples from three aluminum bronze components recently removed from service	B2.1.37	Prior to January 2013.

Table A4-1 License Renewal Commitments

Item #	Commitment	LRA Section	Implementation Schedule
	will be tested. • The samples will be tested for chemical composition including aluminum content, mechanical properties (such as yield and ultimate tensile strengths) and microstructure. • The structural integrity analyses will be updated, as required. • The results of the testing and any required changes to the structural integrity analyses will be completed and sent to the NRC staff for review.		CR 12-22150