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0CAN070801

July 23, 2008

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Responses to Request for Additional Information
Proposed Alternative for Containment Inspection Interval
Arkansas Nuclear One, Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6

REFERENCE:
1. Entergy Letter to the NRC dated September 27, 2007, "Request ANO-CISI-001 – Proposed Alternative for Containment Inspection Interval" (0CAN090702)
2. NRC Letter to Entergy dated June 2, 2008, "Arkansas Nuclear One, Units Nos. 1 and 2 – Request for Additional Information Regarding Relief Request for Use of an Alternate Inspection Interval for Containment Building Structures (TAC No. MD6897 and MD6898)

Dear Sir or Madam:

In Reference 1, Entergy Operations, Inc., (Entergy) requested approval of a proposed alternative to the Arkansas Nuclear One, Unit 1 (ANO-1) and Unit 2 (ANO-2) Containment Inservice Inspection (CISI) interval. The ASME Boiler and Pressure Vessel Code (1992 Edition with 1992 Addenda and 2001 Edition with 2003 Addenda), Section XI, Subsection IWL-2421(b) permits an alternate inspection interval for containment building structures at sites having more than one containment building, provided certain conditions are met.

The NRC sent a Request for Additional Information (RAI) via Reference 2. Reference 2 requested the responses be provided within 45 days of receipt of that letter. Reference 2 was received by ANO on June 17, 2008. This submittal is to provide the requested information.

No new commitments are contained in this submittal.

Should you have any questions regarding this report, please contact me.

Sincerely,

Dale E. James

DEJ/rwc

Attachments: 1. ANO Responses to the NRC's Request for Additional Information
2. Summaries of ANO-1 Containment Inspection Surveillances
3. Summaries of ANO-2 Containment Inspection Surveillances

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Attachment 1 to

0CAN070801

**ANO Responses to the NRC's
Request for Additional Information**

Containment Inspection Interval
RAIs and Responses

<u>NRC RAI 1</u>

For all past surveillances, please provide pertinent information for both ANO-1 and ANO-2 post-tensioning systems which show satisfaction of the applicable acceptance criteria for the wire tests, corrosion protection medium evaluations, concrete inspections and anchor assembly verification.

Response to RAI 1

Attachment 2 provides summaries of the surveillance records for ANO-1. The summaries for ANO-2 are provided in Attachment 3.

<u>NRC RAI 2</u>

Please provide the ANO-1 and ANO-2 tendon performance history of pre-stressing forces.

Response to RAI 2

During earlier discussions with the NRC, it was agreed upon that a list of the submittal date and the letter number for the submitted tendon surveillance reports would be sufficient to respond to this request. The Staff also requested information regarding any regression analyses performed for either unit. This information is provided below.

The date and letter numbers provided below are for the latest supplements / corrections made to the surveillance report.

Inspection Interval	ANO-1	ANO-2
1 year	September 11, 1975 1CAN097508	Note 1
3 year	November 4, 1977 Letter number 1-117-4	April 17, 1981 Letter number 2R-0481-06
5 year	August 22, 1979 Letter number 1CAN087909	May 30, 1984 Letter number 2CAN058418
10 year	May 30, 1984 Letter number 1CAN058409	September 9, 1988 Letter number 2CAN098801

15 year	July 20, 1988 Letter number 1CAN078810	Note 1
20 year	March 1, 1994 Letter number 1CAN039401	Note 1
25 year	June 29, 2000 Letter number 1CAN060004	April 11, 2006 Letter number 2CAN040601
30 year	December 20, 2004 Letter number 1CAN120404	N/A

Note 1 The ANO-2 containment meets the guidelines established in Regulatory Position C2 of Regulatory Guide (RG) 1.35, Revision 1 for identical containment structures on one site, without environmental or other apparent differences, constructed in a continuous manner by the same contractor. Therefore only a visual surveillance was performed. If the acceptance criteria listed in RG 1.35 is exceeded or if abnormal material behavior is detected then a report to the NRC is required. The results of the surveillance for this time interval did not exceed any acceptance criteria and no abnormal material behavior was detected; therefore no submittal was made to the NRC.

Regression Analysis

ANO-1

In reviewing Information Notice 99-10, it was determined that ANO had used the linear regression analysis for trending of the hoop tendons for the ANO-1 15-year surveillance in response to a NRC question. The question was that for the horizontal tendons (hoop) which were surveyed in more than one surveillance, a trend in the measured lift-off forces indicated that the prestressing forces in these tendons would be below the minimum design required value before the end of the design service life or in some cases before the next scheduled surveillance.

In response to this concern, Entergy presented the results of a detailed study of all tendons which have been inspected more than once indicating that the tendon force loss was greater in hoop tendons than in dome and vertical tendons. This was mainly attributed to the effect of friction and curvature. It appeared that the detensioning and retensioning had resulted in additional losses. In view of these findings, it was determined that the prestressing forces in tendons inspected more than once are not representative of the forces as a group. The prestressing forces of all tendons inspected should be taken into consideration to establish the group tendon force trend. A statistical regressing analysis was performed on the basis of all the data obtained for the horizontal tendons from all the surveillance performed to date together with their initial stressing forces. The results of the analysis indicated that the trend of the tendon forces is such that they will meet the minimum design requirement for the 40 year service life.

The NRC provided its safety evaluation for the ANO-1 15-year tendon surveillance in letter dated March 28, 1990 (1CNA039004). The staff reviewed the response and found that the detailed analysis of each group of tendons, with differentiation between tendons inspected once and those inspected more than once, appears to demonstrate convincingly that reductions in tendon forces larger than normal in hoop tendons which have been inspected more than once are due to the slow release of curvature friction and the effect of detensioning and retensioning on tendon behavior. Therefore, it appears rational that the prestressing forces in these tendons cannot be solely taken to represent the tendon forces of the tendon group.

The Staff concurred with ANO's conclusion that no abnormal degradation has occurred in the post-tensioning system used at ANO-1.

It should be noted that the regression plots have been provided with the tendon surveillance reports.

A regression analysis was performed on each of the tendon groups (hoop, vertical and dome) as part of the 30th-year surveillance. The analysis showed that each group remained above the minimum requirements beyond the next surveillance period and out to the 40 year current plant life. Projections at that time show the horizontals to be at 1270 kips with a minimum requirement of 1234 kips, vertical tendon projection of 1368 kips against a minimum requirement of 1237 kips and the projection of the dome tendons at 1349 kips against a minimum of 1252 kips.

By letter dated January 10, 2001 (1CNA010106), the NRC issued the ANO-1 License Renewal Safety Evaluation Report (SER) with open items. One of the open items dealt with the prestress monitoring and trending activities. ANO-1 provided the requested information in letter dated March 14, 2001.

In response, ANO-1 stated that the tendon surveillance is performed every five years as required by ASME Section XI, Subsection IWL. During the surveillance, lift-off forces are measured and evaluated for adequacy as required by IWL. Graphs for each group of tendons (hoop, dome, and vertical tendons) provide the age related expected normalized tendon force plotted on a log-normal graph. These graphs were developed based on the tendon group and the aging effects on the reactor building concrete properties, the wire properties, and the initial prestress force. The lift-off values obtained during the tendon surveillance are plotted in the graphs and trended to determine if the tendon system is performing as expected.
Should trending indicate that prestress in a tendon group may be inadequate to meet the minimum required prestress before the next scheduled tendon surveillance, action will be taken to correct the problem. This may include re-tensioning, replacing tendons, or reanalysis of the reactor building to assure adequate prestress to meet design requirements.

ANO-2

With regards to the regression analysis for ANO-2, the Staff submitted a Request for Additional Information (RAI) to see the trend lines of the projected prestressing forces for each group of tendons based on the regression analysis of the measured prestressing forces during the ANO-2 License Renewal review stages. ANO-2 provided these trend lines in the response to the question in letter 2CAN060403, dated, June 16, 2004.

It was noted in that response that prior to implementation of ASME Section XI, Subsection IWE/IWL, ANO-2 took credit for results of the ANO-1 reactor building tendon inservice inspection, as allowed by code due to similarity of the two containments. The curves that were attached were not based on a regression analysis per Information Notice (IN) 99-10. However, Entergy did evaluate its current method against the regression analysis outlined in IN 99-10 during the ANO-1 15-year surveillance. This analysis showed that the measured tendon prestress forces are well within the projected losses when compared against the original curve data.

Entergy began using a random sampling software program for tendon selection in 1999 for the ANO-1 25-year and the ANO-2 20-year surveillance in accordance with the requirements of 10 CFR 50.55a. Entergy used a design of 8% relaxation loss and a “normalized force” calculation to account for elastic losses during initial tensioning. ANO has not experienced relaxation losses greater than expected during tendon surveillances. The trending results of the hoop, dome and vertical tendons were provided in that submittal.

As noted in the NRC’s Safety Evaluation (SE) for License Renewal, the Staff did not find the trend lines acceptable as part of the analysis. The Staff requested a supplemental clarification to the RAI.

In a letter dated September 10, 2004, Entergy provided the following information:

> Consistent with 10 CFR 50.54(c)(1)(iii), loss of tendon prestress will be adequately managed during the period of extended operation by continued implementation of tendon inspections required by ASME Code Section XI IWL. Relevant operating experience, including experience with prestressing systems described in NRC Information Notice (IN) 99-10 will be considered during inspections and data analysis. Prior to the period of extended operation, trend lines for ANO-2 tendon prestressing forces will be developed using regression analysis in accordance with guidance provided in NRC Information Notice (IN) 99-10. If future tendon examination data diverge from the expected trend, the discrepancy will be addressed in accordance with requirements of the Containment Inservice Inspection (ISI) Program (IWE/IWL) and the current licensing basis. Specifically, if prestressing force trend lines indicate that existing prestressing forces in the containment would go below the minimum required values (MRVs) prior to the next scheduled inspection (Reference 10 CFR 50.55a(b)(2)(ix)(B) or 10 CFR 50.55a(b)(2)(viii)(B)), then systematic retensioning of tendons, a reanalysis of the containment or a reanalysis of the post-tensioning system is warranted to ensure the design adequacy of the containment.

The Staff found this response acceptable.

It should be noted that the commitment made for License Renewal to develop the trend lines discussed above is open (e.g., the trend lines have not been developed to date).

<u>NRC RAI 3</u>

What effect, if any, has the Steam Generator replacement had on ANO-1's code required IWL surveillance and inspection program.

Response to RAI 3

The concrete construction opening that allowed the replacement of the steam generators was originally centered on the 270º mark (due west) and was to be approximately 11' 4" wide on each side of the 270º mark. Due to other issues, the concrete construction opening was widened an additional 8" on the southern side of the 270º mark. The top and bottom elevation of the construction opening were at elevation 425' 6" and 401'-6", respectively.

A total of thirty-four horizontal and thirty-six vertical tendons were affected by the steam generator replacement (SGR). Thirty vertical tendons (V60, V61, V62, V63, V64, V65, V66, V67, V68, V69, V70, V71, V72, V73, V74, V81, V82, V83, V84, V85, V86, V87, V88, V89, V90, V91, V92, V93, V94, AND V95) and eighteen horizontal tendons (21H16, 21H17, 21H18, 21H19, 21H20, 21H29, 21H30, 21H31, 21H32, 31H17, 31H18, 31H19, 31H20, 31H29, 31H30, 31H31, 31H32, and 31H33) were detensioned and retensioned. Sixteen horizontal tendons (31H21, 21H21, 31H22, 21H22, 31H23, 21H23, 31H24, 21H24, 31H25, 21H25, 31H26, 21H26, 31H27, 21H27, 31H28 and 21H28) and six vertical tendons (V75, V76, V77, V78, V79, and V80) were removed and replaced.

The ANO-1 Containment Inservice Inspection (CISI) program has recently completed a 10-year update in accordance with the requirements of 10 CFR 50.55a. As a result, the provisions of the 2001 Edition with 2003 Addenda of the ASME Code, Subsection IWL for tendons impacted by repair / replacement are applicable to tendons affected by the SGR activity. These code provisions are mandatory under 10 CFR 50.55a unless relief or alternative is approved by the NRC.

<u>NRC RAI 4</u>

Provide pertinent records and evaluations of any water intrusion for ANO-1 and ANO-2 post-tensioning ducts.

Response to RAI 4

A summary of the surveillance records as they relate to water intrusion is provided below.

<u>ANO-1</u>

No water intrusion was noted in the one-year surveillance report. The sheathing filler sample from the field end of tendon V19 had 12.7% water content (water content of 10.0% is the maximum allowed by the acceptance criteria.) The sample from the shop end of tendon V19 had only 3.5% water content. Thus, the sheathing filler for tendon V19 is considered acceptable according to the operating procedure.

During the three-year surveillance, the sheathing filler from every surveillance tendon met the acceptance criteria and seven tendon wires which were removed during the surveillance had no corrosion when inspected upon removal from the respective tendons.

During the five-year surveillance, the sheathing filler from every surveillance tendon met the acceptance criteria and five tendon wires were removed during the surveillance and were found to have no corrosion.

During the ten-year surveillance tendon V73 was found to have two ounces of water in the field end. Three sheathing filler samples were obtained with two of the three samples having a higher water content compared to the other grease sample analyses. All three grease sample analyses were within the allowable tolerance. A wire sample was removed for tensile testing and found acceptable.

During the fifteenth-year surveillance, three tendons were found to have small quantities of moisture detected. Tendons V70, V72, and V98 were found to have two, one-half, and one ounce of observable moisture inside of the grease can, respectively. Water was not found in any other surveillance tendon during removal of the grease can nor inside of it. The sheathing filler samples tested had acceptable results.

During the twenty-year surveillance, an observable amount (less than 2 ounces) of water was found on the field end of tendon V101. Two grease samples were taken and submitted for chemical testing. The first sample had unacceptable results but the second sample had acceptable results. The anchorage hardware was Level 1 – bright metal with no visible oxidation. A wire was also removed from tendon V101 for testing and the total length of the wire was Level 1 – bright metal with no visible oxidation.

No surveillance, gasket repair or grease can replacement tendon exhibited water, either during removal of the grease can, or around the tendon anchorage except V80 shop end (top) during the twenty-fifth year surveillance. The shop end of tendon V80 showed drops of condensation during gasket removal. The quantity of water found was insignificant, the gasket was replaced and the inspection of the anchorage components showed no deterioration whatsoever. Although the grease can replacements were not part of the surveillance, a large quantity of cans were changed with no water found in any replaced vertical can. The sheathing filler (grease) samples were tested and found to have acceptable results.

During the removal of the grease can and physical inspections of the anchorage assemblies during the 30th-year surveillance no water was detected in any of the grease caps or on any of the anchorage components. None of the surveillance tendons exhibited any water either during removal of the grease can, detensioning or around the tendon anchorage at any time.

ANO-2

No indication of water in the system was provided in the one, three and five-year surveillance reports.

During the ten-year surveillance, tendon 31H36 field end had two ounces of water found in the grease can. The grease was discolored as it was for tendon 12H18 shop end. Laboratory testing of the grease for water found the water content below 1% for both tendons. Therefore, the occurrence of discoloring was localized and the condition of water being present was not a sign of degradation of the system. It was most likely the water was present from a leaking seal. Since the seals were replaced during the surveillance and the water content was at acceptable levels, the condition was accepted as is.

During the 15th-year surveillance a small section of grease from tendon 31H25 shop end was tan colored, but laboratory analysis revealed an acceptable result of 0.14% water content (acceptance limit is 10%) and visual inspection revealed corrosion conditions to all anchorage components at the shop end were Level 1 – “no visible oxidation or pitting” and were acceptable. Tendon V74 field end exhibited drops of water and it was not possible to obtain a sample. No water was detected during removal of a can, or inside it on any other surveillance tendon.

During the 20th-year visual surveillance, no surveillance, gasket repair or grease can replacement tendon exhibited water, either during removal of the grease can, or around the tendon anchorage.

The 25th-year surveillance found one noteworthy indication that did not require engineering evaluation under IWL-3300 but was required to be documented. IWL-2525.19b required samples of free water to be taken “when present in quantities sufficient for laboratory analysis.” Approximately 2 ounces of free water was detected in the tendon cap for tendon 12H07. This amount is consistent with condensation in the end cap. Samples of the water were not obtained because the quantity noted was insufficient to allow laboratory analysis.

Grease samples on the shop end of tendon 12H07 showed a moisture content of 0.18% which is well below the 10% acceptance criteria. The 1992 edition and addenda of IWL, which were in effect at the time of the surveillance, do not define acceptance criteria for moisture content in the grease. Entergy used the 10% moisture content acceptance criteria established in later edition and addenda of code and used in 10 CFR 50.55a for reporting requirements.

Attachment 2 to

0CAN070801

Summaries of ANO-1 Containment Inspection Surveillances

Summaries of the ANO-1 Containment Inspection Surveillances

Acceptance criteria for water content and water soluble ions for all inspection surveillances

A sample of sheathing filler was removed from each end of each surveillance tendon. Chemical tests were performed on one sample for each tendon. The sample analyzed was selected arbitrarily from the tendon shop or field end with an effort made to use approximately the same number of shop and field end samples. The maximum acceptance limit of 10 parts per million (ppm) for water-soluble chlorides, nitrates, and sulfides are the same as given by ASME Section III, Division 2 – "Code for Concrete Vessels and Containments" for new sheathing filler. No limit for water content was given by the ASME Code editions and addenda in effect for these surveillances. A maximum limit of 10 percent by weight for water was used.

1-year

The anchorage and sheathing filler inspection showed that the anchorage components were in an "as installed" condition with either bright metal or reddish brown appearance with no pitting apparent. No cracking of anchor heads, shims, or bearing plates had occurred and the sheathing filler from every surveillance tendon meet the acceptance criteria for chemical composition.

Eleven discontinuous or missing wires were found in the surveillance tendons, but the distribution was such that no abnormal degradation of the containment structure is indicated. None of the vertical or dome tendons had discontinuous wires. Three dome tendons, and one hoop tendon had one missing wire each. One hoop tendon had three discontinuous wires which were broken during original installation. Two hoop tendons had two discontinuous wires each. Three or fewer discontinuous wires in one tendon was considered acceptable according to operating procedures.

Inspection of tendon wires which were removed revealed no apparent corrosion. All wire samples tested had ultimate strength exceeding the guaranteed minimum ultimate strength.

3-year

After the sheathing filler was cleaned off, the anchorage components were inspected for corrosion, cracks and buttonhead size and condition. The corrosion of anchorage components was found to be either corrosion Level No. 1 – "Bright metal, no visible oxidation" or corrosion Level No. 2 – "Reddish brown, no pitting" in every case. No cracking of anchor heads, shims, or bearing plates were apparent, and no split buttonheads were found.

All surveillance tendons were detensioned and visually inspected for discontinuous wires. Twenty-one of the twenty-three surveillance tendons were subjected to an additional positive verification of wire continuity by pulling each wire and observing motion on the opposite end. For the other two tendons, the wire continuity test could not be performed because one of the stressing washers on each tendon could not be pushed with available equipment along the tendon far enough to allow pulling each wire to check continuity. In these cases, some of the wires were checked by pulling the wire and observing motion. The remaining wires were checked by pulling on the free end until the wire held a force higher than the force normally needed to move a wire. A total of thirteen wires were either missing or had anomalies which prevented them from being fully effective; the greatest number of missing or ineffective wires in any one tendon was three. No service related wire breaks were encountered. The number and distribution of missing and ineffective wires has no significant effect on the strength of the tendon system.

Field tensile tests were performed on twenty 100-inch wire samples from 6 wires. All wire samples, except for those from tendon 32H14, had ultimate strength exceeding the minimum guaranteed ultimate strength of 240,000 psi. The inspection wire from tendon 32H14 had three out of four samples with ultimate strength less than the guaranteed minimum ultimate strength. To further investigate the wire strength results, ten 10-inch samples of the wire from tendon 32H14 were tested. Four of the ten samples failed at less than 240,000 psi, but all ten of the samples failed inside the wire gripping jaws making the tests invalid. A second set of tensile tests was done using nine 10 inch wire samples from the inspection wire from tendon 32H14. Two of the nine samples failed below the required ultimate strength. A metallurgical investigation was conducted to determine the reasons for the low values obtained on some of the tensile specimens from tendon 32H14. The investigation concluded that the tensile test results obtained for the inspection wire from tendon 32H14 are not indicative of any deficiencies in the wire but rather are due to improper wire removal procedures which caused a permanent set in the wire.

5-year

The anchorage inspection showed the anchorage components to have no corrosion and no cracking.

The sheathing filler from every surveillance tendon set met the acceptance criteria levels of water-soluble ions (chlorides, nitrates, and sulfides) and water content.

All surveillance tendons were detensioned and visually inspected for evidence of discontinuous wires. The twenty-one surveillance tendons were subjected to an additional positive verification of wire continuity by pulling one-third of the wires and attempting to observe motion on the opposite end of each pulled wire. In some cases, a great deal of difficulty was encountered in moving the stressing washers back far enough on the field ends to observe motion. If motion could not be observed, continuity was verified by pulling the wire to a force of 1000 pounds on the free end of the wire. In each case, relaxation of the ram resulted in the wire moving backward to a level consistent with the other pulled wires. As a validation of this positive continuity test, removed test wires were purposely pulled a short distance after the buttonhead was cut and no relaxation of these wires was observed.

A total of twelve wires were either missing or had anomalies which prevented them from being fully effective; the greatest number of missing or ineffective wires in any one tendon was four, with the exception of tendon 32H14, which is a special case. Details of this tendon are provided in the tendon surveillance report. No service related wire breaks were encountered.

The number and distribution of missing and ineffective wires has no significant effect on the strength of the post-tensioning system.

Field tensile tests were performed on fourteen 100-inch wire samples from five wires. All wire samples, except for that from tendon 3D2, had ultimate strength exceeding the minimum guaranteed ultimate strength of 240,000 psi. The inspection sample from tendon 3D2 exhibited yield, ultimate and elongation characteristics which corresponded to the more detailed inspection and testing program presented in the five-year tendon surveillance report issued to the NRC. Detailed testing of the wire removed from tendon 3D2, recorded as breaking during initial tensioning, concluded that a ten-foot section of that wire did not meet minimum design strength requirements. It is considered to be an isolated case, however, and is not indicative of any system degradation.

10-Year

The sheathing filler had acceptable levels of water-soluble chlorides, nitrates, and sulfides and water content.

All anchorage components except the shop greasing cap of tendon V25 had adequate filler coverage. The lack of coverage for the V25 grease cap was not deemed serious. The corrosion level of all the anchorage components was found to be mostly Level 1 (bright metal, no rust), with a small amount of Level 2 (reddish brown, no pitting) present.

Only four wires were found to have anomalies. These anomalies, which were judged to be inconsequential to the post tensioning system, included: a wire which was not present at the field end but was present at the shop end (tendon 32H14), one wire not buttonheaded at the field end (tendon 32H15), and two wires which were sheared off during detensioning (tendon 3D02). All wires tested exceeded the minimum of 192 KSI yield, 240 KSI ultimate and 4% elongation.

15-Year

The sheathing filler samples tested had acceptable results for levels of water-soluble ions (chlorides, nitrates, and sulfides) and water content.

The corrosion level of all the anchorage components was either Level 1 entirely (bright metal, no rust) or a small area of Level 2, (reddish brown, no pitting) was detected on the component.

No additional broken or missing wires were found on any of the inspected tendons. All wire samples tested were found to be acceptable in diameter, yield strength, tensile strength and elongation.

20-Year

A wire was removed from each group of tendons (e.g., hoop, vertical, dome) for corrosion investigation and physical testing. In addition, dome tendon 3D120 was inspected as a result of a recommendation from the fifteenth year tendon surveillance report. A wire was removed from tendon 3D120 to check corrosion levels after regreasing problems were noted during the last surveillance. The corrosion condition of all wires was Level 1 (no visible oxidation or pitting) throughout their entire length.

The wire samples all exceeded the yield and ultimate strength minimum values of 192,000 and 240,000 psi, respectively, and the elongation value of the wire at failure exceeded the four percent minimum for all samples.

Initial samples from tendon 3D120 passed the yield strength test but failed to meet the ultimate strength value of 240,000 psi. Several samples also failed to reach the elongation requirement of four percent.

A second wire was removed to allow additional testing. When similar results were achieved all of the samples were sent for analysis by an independent source. Samples of one the wires removed from the tendon for surveillance were also tested to verify the results achieved during site testing.

The results of the independent tests confirmed the field tensile test results. The tensile strength for tendon 3D120 was slightly lower than the minimum required whereas the yield strength was higher than the minimum required. Based on the results of chemical composition, hardness tests, and visual and metallographical examination, the carbon and manganese contents of tendon 3D120 were determined to be slightly lower than the wire from the surveillance tendon which resulted in a slightly lower tensile strength than tendon 3D120. This was the original condition from the wire mill; it is not a sign of degradation during service. It was concluded that the slightly lower tensile strength of tendon 3D120 presented no practical consequences.

Since tendon wire 3D120 exceeded the minimum required yield strength, with margin, and no corrosion was evident, tendon 3D120 is considered acceptable for service and continues to meet the design intent based on engineering judgment. The results of the testing and analysis of tendon 3D120 substantiated the conclusion reached in the fifteenth year surveillance that the large grease replacement associated with this tendon did not indicate system degradation.

25-Year

The sheathing filler samples were tested and found to have acceptable levels of water-soluble ions and water content. Four of the twenty-five samples tested (tendons V80, 2D227, 2D229 and 21H8) revealed nitrate levels above the 10 ppm limit. Conformational tests on the second samples from these ends revealed acceptable results.

Acceptable corrosion levels were found to all tendon ends and no cracks were found on any anchorage components. Cracks surrounding the bearing plates were within allowable tolerance of ≤ 0.010” except for 31H08 shop end which had a crack > 0.030”, thirteen inches long.

There are two cracks. The first is a diagonal crack approximately 13” long, having a maximum crack width of 0.030”, and radiating upward at a 45º angle from the edge of the base plate. The second crack is approximately 5” long, having a maximum crack width of 0.01”, and radiating downward at a 45º angle from the edge of the base plate. These cracks were found in the concrete at the shop end of horizontal tendon 31H08 on buttress #3. The 13” long crack extends around the chamfered corner of the buttress onto the face of the buttress. The 5" long crack is located on the concrete adjacent to the tendon base plate since it is not long enough to reach the chamfered edge of the buttress. The tendon base plate is 3" thick, 24" wide and extends on each side of 31H8 for at least one tendon.

Based upon location and characteristics the crack origin appears to be Poisson effect/creep induced cracking. Poisson effect cracking is caused by the physical "shrinking" of the building as the tendons are tensioned (i.e., as the building shrinks in height, the sides would slightly bulged) and the redistribution of mass causes a stress riser near the anchor attachments. This almost immeasurable movement / stress concentration can generate a crack almost immediately after the initial tendon tensioning. One the initial stress is relieved by the crack generation, there is no additional crack propagation. This phenomenon is confirmed by the observation that the crack appears inactive.

No repair / replacement activity is required at this time.

Based on the location, orientation and inactivity of the crack, the reactor building is considered to be acceptable in its current condition.

No additional broken or missing wires were found on any of the inspected tendons except tendon 21H08. This tendon was found to have one missing buttonhead during inspection and one broken wire after detensioning.

All wire samples, including two additional wires tested from tendon 21H08, were found to be acceptable in diameter and corrosion condition. Both the ultimate strength and yield strength exceeded acceptance criteria for all samples and all elongations exceeded 4% except one. Samples of the two wires from tendon 21H08B were taken from a broken wire adjacent to the break in the wire and were sent for metallurgical testing.

Four test wire samples were cut from these two wires for the metallurgical evaluations. The evaluations concluded the primary mechanism of test wire failure during the tests was ductile tensile overload. Test Wire #1 and #3's most probable cause of failure was overtensioning during original installation. The most probable cause for the failure of Test Wire #2 was that it was partially saw cut during original installation. Test Wire #4's most probable cause of failure was a manufacturing defect (piping porosity in the original ingot).

No repair / replacement are required since tendon 21H08 is code qualified in its present condition.

During the concrete surface examination two deficiencies were identified. These deficiencies were exposed reinforcing steel in a tendon low point drain blockout and a piece of wood in the exterior face of the Reactor Building at approximately azimuth 290, elevation 358'.

The exposed rebar is an outside horizontal #11 bar that is exposed for approximately 4" at a low point drain for tendon 32H18. The rebar is located below the personnel airlock at elevation 387'6". The personnel airlock is located in the Upper North Electrical Penetration Room inside the Auxiliary Building and is not exposed to the elements. Only about the top 1/3 of the rebar is exposed and does not show evidence of extensive rusting. The apparent cause of this condition is inattention to detail when forming the blockout pockets for the tendon low point drains or high point vents in these locations during original construction.

No repair / replacement activity was required on this condition. Action was taken to wire brush the mil scale, prep and coat the exposed steel with epoxy coating to protect the rebar from further corrosion. This work is not considered to be a "code" repair because the rebar is still able to perform its design function without being coated and coating, by itself, is considered to be cosmetic by inspection.

It was believed that the exposed wood was a 2 x 4 piece of form lumber at azimuth 291 degrees, 37 minutes, elevation 360' that was not removed when the original construction opening was closed. This wood was removed and determined to be a wooden wedge to provide adequate clearance between the outer layer of rebar and the inner face of the steel formwork.

Even though the wood was determined to have no detrimental effect it was removed based on industry experience. Industry experience suggests a piece of form wood left in the concrete could wick moisture allowing corrosion.

The wood was removed, the concrete roughened and prepared and the void was grouted flush to the surface to prevent water intrusion and potential long-term degradation. The repair of this defect is considered to be a "cosmetic repair" and not a structural repair of the containment building structure. It has been classified "cosmetic" because the outer layer of reinforcing steel has not been exposed and there is no other damaged material in the vicinity.

30-Year

The sheathing filler samples were tested and found to have acceptable levels of water-soluble ions and water content. All neutralization numbers were above the IWL requirement and acceptable. No visible breakdown of the grease was noted either by color or consistency for all samples tested.

Acceptable corrosion levels were found on all tendon ends and no cracks were found on any anchorage components. All of the bearing plates were found with acceptable levels of corrosion, Level 1, 2, or 3. Concrete cracks surrounding the bearing plates were within allowable tolerance of ≤ 0.010" except for one tendon where a 0.030" crack was previously reported. The inspection shows that this condition has not changed from the previous inspection.

No broken, missing, or protruding wires were found on any of the surveillance tendons. All wire samples tested were found to be acceptable in diameter, yield strength and ultimate strength.

Attachment 3 to

0CAN070801

Summaries of ANO-2 Containment Inspection Surveillances

Summaries of the ANO-2 Containment Inspection Surveillances

Acceptance criteria for water content and water soluble ions for all inspection surveillances

A sampling of the sheathing filler was removed from each end of each surveillance tendon. Chemical tests were performed on one sample from each tendon. The maximum acceptance limits of 10% by weight for water and 10 parts per million (ppm) for water-soluble chlorides, nitrates, and sulfides. The ASME Code editions and addenda in effect during these surveillances did not provide a limit for water content and the limits for the water-soluble ions are the same as given by ASME Section III, Division 2 – Code for Concrete Reactor Vessels and Containments for new sheathing filler.

1 year

The results from the chemical analyses of the sheathing filler were found to be acceptable. The shop end of tendon 31H4 contained approximately one cubic inch of light tan colored grease around the stressing washer center hole. A sample was taken containing the grease and sent for testing in addition to the field end sample, which had been sent for testing previously. Results of the additional test were acceptable. A lesser amount, too small to sample was observed around the field end of tendon 32H45. Discussion with craft personnel who installed the tendons indicated the material was a product called “LUBRAPLATE”, used to grease the stub rod during tensioning. It appears that in these two cases, the material was not completely cleaned from the threads and migrated to the opening during tendon filling operations. The tan colored material was not mixed with the sheathing filler, which corresponds to a characteristic of LUBRAPLATE – not mixing with other types of grease. “LUBRAPLATE” is a hydrocarbon compound and should have no adverse effect on the sheathing filler.

After the sheathing filler was cleaned off during the one-year surveillance, the anchorage components were inspected for corrosion. Corrosion of anchorage components was found to be either corrosion Level 1 – “Bright metal, no visible oxidation” or corrosion Level 2 – “reddish brown, no pitting” with the exception of the lower bearing plates of V7 and V101. The lower bearing plates for these tendons showed a slight amount of pitting at the edges, external to the grease cap, where the protective paint had peeled off. ANO-2 was aware of the problem with moisture in the tendon gallery and has a program for repainting those areas where the protection had come off. The pitting was surface only and had no effect on the integrity of the system. No cracks in anchor heads, shims or bearing plates were observed.

Four wires from the twenty-one surveillance tendons showed anomalies which were judged to be inconsequential to the overall tendon system. Specifically, one wire was discontinuous from tendons 12H2 and 2D21,each, and two wires were discontinuous from tendon 3D20. In none of the cases where discontinuous wires were observed were buttonheads or portions of broken wires found in the sheathing filler. The missing wire from 12H2 was recorded.

3-year

All sheathing filler samples tested met the acceptance criteria for water and water-soluble ions.

Corrosion of anchorage components were found to be either corrosion Level No. 1 – "Bright metal, no visible oxidation" or corrosion Level No. 2 – "Reddish brown, no pitting." The only exceptions were the lower bearing plates of V49 and V68. The lower bearing plates showed a slight amount of light pitting at the edges, external to the grease cap, where the protective paint had peeled off. The pitting was surface only, and had no effect on the integrity of the system. No cracks in anchor heads, shims, or bearing plates were observed.

Tendons 12H02, V101 and 3D111 were inspected during both the ANO-2 one-year and three-year tendon surveillance. This procedure is associated with ANO-2 TS 4.6.1.5.1 for developing a history of tendon performance.

5-year

All sheathing filler samples tested met the acceptance criteria for water and water-soluble ions.

Corrosion of anchorage components was found to be either corrosion Level No. 1 – "bright metal, no visible oxidation" or corrosion Level No. 2 – "reddish brown, no pitting". No cracks in anchor heads, shims, or bearing plates were observed.

Tendons 12H102, V101 and 3D111 were inspected during the ANO-2 one-year, three-year and five-year surveillance. This procedure is associated with ANO-2 TSs for developing a history of tendon performance. The surveillance findings of these three tendons were compared to the results of the one and three-year surveillances. This comparison revealed no change in the corrosion status of the sheathing filler and no additional wires have broken since the first and third surveillance.

10-year

All sheathing filler samples tested met the acceptance criteria for water and water-soluble ions.

Corrosion of anchorage components was found to be either corrosion Level No. 1 – "bright metal, no visible oxidation" or corrosion Level No. 2 – "reddish brown, no pitting". No cracks in anchor heads, shims, or bearing plates were observed.

All tendons inspected during this surveillance had never been inspected in previous surveillances. The data from this surveillance are consistent with the results obtained in past surveillances.

15-year

All sheathing filler samples tested met the acceptance criteria for water and water-soluble ions.

Corrosion of anchorage components was found to be either corrosion Level No. 1 – "bright metal, no visible oxidation" or corrosion Level No. 2 – "reddish brown, no pitting". The anchor head to 1D318 field end showed mill scale evident around the entire side which would have been present at installation as the general corrosion was Level 1. No cracks in anchor heads, shims, or bearing plates were observed.

20-year

All sheathing filler samples tested met the acceptance criteria for water and water-soluble ions.

Corrosion of anchorage components was found to be either corrosion Level No. 1 – "bright metal, no visible oxidation" or corrosion Level No. 2 – "reddish brown, no pitting". No cracks in anchor heads, shims, or bearing plates were observed.

The concrete was inspected extending 2' from the edge of the bearing plates for cracks. No cracks that had a width in excess of 0.010" were found to any inspection tendon. Two instances of exposed reinforcing steel on the concrete surface were noted during the inspection.

The two instances are (a) an outside horizontal # 10 bar that is exposed for approximately 4" at a high point vent for three Containment Building tendons and (b) exposed # 8 and # 4 rebar(s) located at the top of Buttress # 3 at elevation 515' on the southwest corner of the buttress. In the first case, the rebar is located in the Containment Purge Fan Room at elevations 404' 4" (tendon 231H20), 408' 4" (tendon 231H21) and 409' 4" (tendon 212H21). The Containment Purge Fan Room is located inside the Auxiliary Building and as such, this rebar is not exposed to the elements. Only about the top 1/3 of the rebar is exposed and does not show evidence of extensive rusting. In the second case, the rebar is a 4" long piece of # 8 vertical bar with about 50% of its cross-section exposed and a 3" long piece of a #4 hairpin bar with about 50% of its cross-section exposed. Only about the top ½ of the rebar is exposed and shows evidence of mill scale rusting. This buttress is exposed to the elements. It is believed this condition was caused by mechanical damage during original construction and was never repaired.

It was determined that the exposed reinforcement bar as found in the Containment Purge Fan Room can adequately perform its function in its present condition.

It is believed the second condition was caused by mechanical damage during original construction and was never repaired. Both the # 8 vertical bar and the # 4 hairpin bar are shown in the Tendon Buttress reinforcing details on the appropriate drawing. The function of the # 8 vertical bar is to prevent cracking / spalling of the corner of the buttress and the function of the hairpin bar is to connect the vertical # 8 bar back into the buttress concrete (the same as a tie bar function for the corner bars of a column). The stress in this area of the buttress is relatively low. There is no corrosion staining from the exposed bar nor any cracking in the adjacent concrete indication it is still able to perform its design function. There is also only slight corrosion (mill scale) on the rebar and therefore the rebar can be fully developed while performing its function.

No repair / replacement activity was required on either of these conditions. Actions were taken to wire brush the mill scale, prepare and coat the exposed reinforcing steel with epoxy coating to protect the rebar from further corrosion. This work is not considered to be a “code” repair because the rebar is still able to perform its design function without being coated and coating, and is considered to be “cosmetic” by inspection.

Bearing plates in most cases were painted and IDs were either illegible or not found.

25-year

All sheathing filler samples tested met the acceptance criteria for water and water-soluble ions.

Corrosion of anchorage components was found to be either corrosion Level No. 1 – “bright metal, no visible oxidation” or corrosion Level No. 2 – “reddish brown, no pitting”. No cracks in anchor heads, shims, or bearing plates were observed. All of the bearing plates were also found to have acceptable levels of corrosion.

Concrete cracks > 0.01” in width were noted on the field sides of tendon 3D128 and tendon 12H26. It was determined that these indications were contained entirely within the surface layers of the concrete and were purely cosmetic in nature. It is believed the cause of these cracks is temperature cracking which occurred during the initial curing of the surface concrete. No repair / replacement activities were required for these indications.

No broken, missing or protruding wires were found on any of the ANO-2 surveillance tendons.

Two discontinuous wires were observed on tendon V109 during pretension following wire removal. Tendon V109 had no visible unseated buttonheads when the VT-1 examinations were performed n either end prior to detensioning the tendon. There were a total of 184 effective wires remaining in the tendon after removal of the discontinuous wires. It was determined that this condition did not prevent the tendon from performing its design function.

The cause of the problem was the improper buttonheading of a test wire during initial construction instead of one of the actual tendon wires. Prior to wire removal for testing, there were 185 effective wires even though there where 186 seated buttonheads on each end. One wire from each end was not connected on the other end. As a result, after wire removal, 184 tendon wires remained for tendon V109. Based on industry experience, this is believed to have been an isolated occurrence. It should be noted that the nature of the error limits the potential problem to at most one wire per tendon, which would not prevent the containment from fulfilling its design function even under the worse case scenario.