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1CAN011404

January 14, 2014

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

SUBJECT: 40th-Year Reactor Building Inspection Report
Arkansas Nuclear One, Unit 1
Docket No. 50-313
License No. DPR-51

Dear Sir or Madam:

Entergy Operations, Inc. (Entergy) conducted the Arkansas Nuclear One, Unit 1 (ANO-1) 40th-Year Tendon Surveillance and Concrete Inspection from April 2013 through June 2013. Pursuant to the requirements of IWL-3300 of American Society of Mechanical Engineers (ASME) Section XI, 2001 Edition with 2002 and 2003 Addenda, as modified by 10 CFR 50.55a and the ANO-1 Technical Specification (TS) 5.6.6, an engineering report was prepared to document the evaluation of the examinations that did not meet the acceptance standards of the ANO-1 Containment Inspection Program. In accordance with ANO-1 TS 5.6.6, the results of this engineering evaluation are to be submitted to the NRC within 30 days of the completion of the evaluation which was completed on December 20, 2013.

The scope of this report is limited to examinations of concrete containments covered by the rules of ASME Section XI, Subsection IWL. Examination of the containment metallic liner and Class MC components is accomplished under the rules of ASME Section XI, Subsection IWE. As such, these examinations are not in the scope of this report.

While no indications were found that challenge current structural integrity or leak tightness of the containment, four indications were found that require evaluation under IWL-3300. A summary of the results is provided in the attachment to this letter.

Based on the results of the engineering evaluation of the 40th-Year Tendon Surveillance and Concrete Inspection, Entergy has concluded that the ANO-1 Reactor Building is capable of performing its design function and should remain capable of performing its design function until completion of the 45th-Year Tendon Surveillance and Concrete Inspection. Additionally, the observed indications do not indicate the presence of degradation in inaccessible areas.

This report includes no new commitments.

If you have any questions or require additional information, please contact me.

Sincerely,

Original signed by Stephenie L. Pyle

SLP/rwc

Attachment: Results of Engineering Evaluation for the ANO-1 40th-Year Reactor Building Tendon Surveillance and Concrete Inspection

cc: Mr. Marc L. Dapas
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Attachment to

1CAN011404

Results of Engineering Evaluation for the ANO-1 40th-Year Reactor Building Tendon Surveillance and Concrete Inspection

Results of Engineering Evaluation for the ANO-1 40th-Year Reactor Building Tendon Surveillance and Concrete Inspection

Entergy Operations, Inc. (Entergy) conducted the Arkansas Nuclear One, Unit 1 (ANO-1) 40th-Year Tendon Surveillance and Concrete Inspection from April 2013 through June 2013. While no indications were found that challenge current structural integrity or leak tightness of the Reactor Building (containment), several indications were found that did not meet the acceptance criteria of the ANO-1 Containment Inspection Program.

Pursuant to the requirements of IWL-3300 of American Society of Mechanical Engineers (ASME) Section XI, 2001 Edition with 2002 and 2003 Addenda, as modified by 10 CFR 50.55a and the ANO-1 Technical Specification (TS) 5.6.6, an engineering report was prepared to document the evaluation of the examinations that did not meet the acceptance standards of the ANO-1 Containment Inspection Program. The engineering report was completed on December 20, 2013. In accordance with ANO-1 TS 5.6.6, the results of this evaluation are to be submitted to the NRC within 30 days of the completion of the evaluation. The results of the evaluation are presented below.

1. **Tendon 3D104 Did Not Meet Elongation Requirements During Retensioning**

IWL-3221.1 states that the condition of tendon force and elongation is acceptable if

(d) the measured tendon elongation varies from the last measurement, adjusted for effective wires or strands, by less than 10%.

The last recorded measurement was at installation. The tendon stressing card from installation in 1972 gives a recorded total elongation of 9.38 inches, with a total calculated elongation of 7.25 inches. The total measured elongation during this surveillance was 7.45 inches. The intent of comparing the calculated and the actual value of elongation is to confirm that the tendon is developed, and that there is no deviation in the tendon stressing system installation. When a stressing ram is pressurized to a defined pressure for a given load, the measurement of elongation confirms that the load is developed in the tendon. A low elongation could mean equipment slippage or an obstruction in the tendon duct, and a high elongation could indicate wire failure or wire slips within the anchorages. At installation, the expected elongation value was calculated. This value was based on the load applied, the length, the cross-sectional area, and the elastic properties of the wires. The value that was calculated as a reference for the elongation measurement was 7.25 inches. In comparison, the measurement that was recorded during this surveillance was 7.45 inches which is a 2.7% variance from the expected valve for this tendon. While no explanation was given for the difference in the original measured and calculated values, the current elongation measurement of 7.45 inches is within the acceptable range that was identified on the original tendon stressing card for this tendon. The current elongation measurement was performed twice with similar results both times. There is no indication of equipment slippage, obstructions, wire failure, or wire slips within the anchorages.

The wire that was removed from tendon 3D104 was tested for yield strength, ultimate tensile strength, and elongation. The results showed that the samples were at, or above, the specified minimum values for each of these material properties which verifies the ability of the tendon wires to perform as designed.

CAUSE OF CONDITION [IWL-3310(a)]:

The low elongation could be an indication of equipment slippage or an obstruction in the tendon duct. Because there were no indications of these and because the measured valve was close to the actual original calculated value, the most probable cause of the variance was a recording error or equipment slippage at initial measurement.

APPLICABILITY OF CONDITION TO THE OTHER UNIT [IWL-3310(b)]

While conditions of this type are possible for Unit 2, this is considered to be an isolated incident, with the findings having no impact on the containment's ability to perform its design function.

ACCEPTABILITY OF CONTAINMENT [IWL-3310(c)]

Based on the above evaluation, it was determined that the measured elongation value is acceptable, and that tendon 3D104 maintains its full capacity to maintain the required post tensioned force. As a result, the containment is acceptable without further evaluation or repair/replacement activities.

REQUIREMENTS FOR REPAIR REPLACEMENT [IWL-3310(d)]

As discussed under the Acceptability of Containment section above, no repair or replacement activities are required.

ADDITIONAL EXAMINATION REQUIREMENTS [IWL-3310(e)]

No additional examinations are warranted for this condition.

2. Tendon 31H05 Was Found With One Missing Buttonhead

IWL-3221.3 states that the condition of tendon anchorage areas is acceptable if

(c) broken or unseated wires, broken strands, and detached buttonheads were documented and accepted during a preservice examination or during a previous inservice examination.

The missing buttonhead has not been previously documented and therefore, is evaluated as required by IWL-3300.

Tendon 31H05 was in the original scope of tendons to be visually inspected. The buttonhead count showed that the shop-end of the tendon at buttress three had one

missing buttonhead, while the field end had no missing buttonheads. This indicates a broken tendon wire. Each tendon for the ANO-1 Reactor Building Post-Tensioning System is designed with 186 wires. Tendon 31H05 currently has 185 effective tendon wires.

CAUSE OF CONDITION [IWL-3310(a)]

While the cause of the condition is unknown, a potential cause could be poor workmanship during construction such as inadequate buttonheading at installation of the tendon.

APPLICABILITY OF CONDITION TO THE OTHER UNIT [IWL-3310(b)]

While conditions of this type are possible for Unit 2, this is considered to be an isolated incident, with the finding having no impact on the containment's ability to perform its design function.

ACCEPTABILITY OF CONTAINMENT [IWL-3310(c)]

Based on the original design bases calculation, a total of seven wires can be missing, removed, or broken from a tendon and still be acceptable. This is based on the required area per tendon as compared to the actual area per tendon that was provided by the design. Based on this design requirement, the single missing wire on Tendon 31H05 does not affect its ability to meet its design function. Additionally, based on the wire testing that has been done per the ASME Section XI, Subsection IWL Surveillance schedule, there has been no indication of degraded tendon wires in the prestress system of the Reactor Building. As described above, this is believed to be an isolated incident, with no observed trend of tendon wire degradation.

REQUIREMENTS FOR REPAIR REPLACEMENT [IWL-3310(d)]

As discussed under the Acceptability of Containment section above, no repair or replacement activities are required.

ADDITIONAL EXAMINATION REQUIREMENTS [IWL-3310(e)]

No additional examinations are warranted for this condition.

3. Three Protruding Wires on Tendon 31H19

IWL-3221.3 states that the condition of tendon anchorage areas is acceptable if

(c) broken or unseated wires, broken strands, and detached buttonheads were documented and accepted during a pre-service examination or during a previous inservice examination.

The missing buttonhead has not been previously documented and therefore, is evaluated as required by IWL-3300.

Tendon 31H19 was an Augmented Scope tendon (tendon which was affected by repair/replacement activities) in the surveillance. The scope of the surveillance for this tendon was a visual inspection, grease sampling, detensioning, and wire removal for testing.

Upon initial inspection of the anchorhead of Tendon 31H19, all of the buttonheads were seated against the anchorhead. The tendon was detensioned, and a wire was removed for testing. Upon initial retensioning of the tendon it was noted that several wires did not seat properly against the tendon anchorhead. The stress was relieved from the tendon, and then it was retensioned a second time. The result of the second tensioning was that all but three of the wires seated. When the tendon was taken to overstress, these three wires seated and then slightly came off of the anchorhead again when the tendon was taken back to the required lock-off stress. Based on the observed conditions of the unseated wires during the detensioning, retensioning, and overstressing operations, the wires are believed to be continuous and effective in the tendon.

CAUSE OF CONDITION [IWL-3310(a)]

The most probable cause of the wires not seating against the anchorhead is that the wires are strangled in the tendon bundle, not that they are discontinuous. When a wire is removed from the tendon bundle, the surrounding wires can be displaced from their original position. Each horizontal tendon bundle is wrapped 240 degrees around the building, and to equalize loading, is given a twist of one revolution per 40 feet of cable. This configuration of tendon wires in the tendon can produce frictional stresses between wires that have a strangling effect on individual wires where the stress is not transmitted all the way back to the anchorhead.

APPLICABILITY OF CONDITION TO THE OTHER UNIT [IWL-3310(b)]

While conditions of this type are possible for Unit 2, this is considered to be an isolated incident, with the finding having no impact on the containment's ability to perform its design function.

ACCEPTABILITY OF CONTAINMENT [IWL-3310(c)]

Because a continuity test was not performed on the three protruding wires, it is not known with certainty that the wires are continuous. In order to determine the acceptability of the tendon, the assumption is being made that the wires are broken. After the removal of one wire, the tendon currently has 185 wires. If the three protruding wires are assumed discontinuous, then there would be a total of four ineffective wires in Tendon 31H19. A total of seven wires can be missing from each tendon and still be considered acceptable. Using this conservative approach, the tendon still meets its design requirements, and remains effective in maintaining the required post-tensioned force.

The wire that was removed from Tendon 31H19 was tested for yield strength, ultimate tensile strength, and elongation. The results showed that the samples were above the specified minimum values for each of these material properties which verifies the ability of the tendon wires to perform as designed.

REQUIREMENTS FOR REPAIR REPLACEMENT [IWL-3310(d)]

As discussed under the Acceptability of Containment section above, no repair or replacement activities are required.

ADDITIONAL EXAMINATION REQUIREMENTS [IWL-3310(e)]

No additional examinations are warranted for this condition.

4. Two Cracks Wider Than 0.010 Inch Were Detected at the Shop-End of Tendon 31H08

IWL-3221.3 states that the condition of the tendon anchorage areas is acceptable if

(d) cracks in the concrete adjacent to the bearing plates do not exceed 0.01 inch in width.

Tendon 31H08 was in the original scope of tendons to be visually inspected, and to have the tendon force monitored. During the visual inspection, cracks that exceeded the 0.01-inch criteria were documented. These cracks were first identified in the 25-year tendon surveillance, which was performed in 1999. At that time, one of the cracks was described as being 13 inches long and greater than 0.030 inch wide, and the other was described as being five inches long and less than 0.010 inch wide. At that time, an evaluation of the cracks was completed, and the reactor building was determined to be functional as is. During the 35-year tendon surveillance, the larger crack was documented as increasing in width from greater than 0.030 to 0.40 inch. This change in width was evaluated per IWL-3300. The evaluation describes the possible causes of the increase in crack width possibly being a result of heat or erosion or possibly just a difference in reporting by inspectors.

The most recent 40-year tendon surveillance documented the first crack as being 30 inches long and 0.60 inch at its widest point, and the other crack as being six inches long and less than 0.20 inch wide. While these cracks have been previously evaluated as required by IWL-3300, the increase in crack width and length requires additional evaluation.

CAUSE OF CONDITION [IWL-3310(a)]

The cracking that was originally identified at the 25-year surveillance was evaluated. Based on the location and characteristics of the cracks, they were determined to be Poisson-effect / creep-induced cracking. This cracking is caused by slight shrinking of the building with the tensioning of the tendons and the associated redistribution of mass in the structure. Once the stress is relieved

by this cracking there is no additional crack propagation. Because Poisson-effect creep-induced cracking does not produce active cracks, other contributing factors were considered. Two potential contributors to the active cracking are weathering and corrosion of reinforcement.

Weathering - Includes cracking from freezing and thawing, wetting and drying, and heating and cooling. This could be a contributor to the active cracking since the crack has been open to moisture and subjected to multiple freeze thaw cycles over the last 15 years.

Corrosion of reinforcement - Cracks provide easy access for oxygen, moisture, and chlorides, and thus, minor splitting cracks can create a condition in which corrosion and cracking are accelerated. Corrosion requires an oxidizing agent, moisture, and electron flow within the metal. The corroding of steel produces iron oxides and hydroxides which have a volume much greater than the volume of the original metallic iron. This increase in volume causes high radial bursting stresses around reinforcing bars and results in local radial cracks that can propagate along the bars resulting in the formation of longitudinal cracks or spalling of the concrete. While there are no visible signs of rust streaks at the bottom of the cracks, corrosion of reinforcement could be a contributor to the active cracking. The most probable cause of the additional cracking is the exposure of the cracks to moisture which has caused weathering and possible minor corrosion of the outer layer of reinforcement in the buttress.

APPLICABILITY OF CONDITION TO THE OTHER UNIT [IWL-3310(b)]

While conditions of this type are possible for Unit 2, this is considered to be an isolated incident. Additionally, the ASME Section XI, Subsection IWL Tendon Surveillance and Concrete Inspection process is considered to be adequate to detect this same condition on Unit 2.

ACCEPTABILITY OF CONTAINMENT [IWL-3310(c)]

Due to lack of evidence of corrosion of the steel reinforcement, margin provided by the robust concrete reinforcing, and length of time of the potential exposure of the steel, it was determined that the steel reinforcing is currently not significantly affected, and the buttress itself maintains its design capacity.

REQUIREMENTS FOR REPAIR REPLACEMENT [IWL-3310(d)]

Both of these contributors to cracking can be eliminated by sealing the area from moisture and oxygen. Using Belzona, a non-structural routing and sealing repair of the crack was completed.

Based on the results of the engineering evaluation of the 40th-Year Tendon Surveillance and Concrete Inspection, Entergy has concluded that the ANO-1 Reactor Building is capable of performing its design function and should remain capable of performing its design function until completion of the 45th-Year Tendon Surveillance and Concrete Inspection. Additionally, the observed indications do not indicate the presence of degradation in inaccessible areas.