



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**  
WASHINGTON, D.C. 20555-0001

June 28, 2017

ANO Site Vice President  
Arkansas Nuclear One  
Entergy Operations, Inc.  
1448 S.R. 333  
Russellville, AR 72802

**SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 2 – REVIEW OF COMMITMENT  
SUBMITTAL FOR LICENSE RENEWAL REGARDING NICKEL-BASED ALLOY  
AGING MANAGEMENT PROGRAM PLAN (CAC NO. MF8154)**

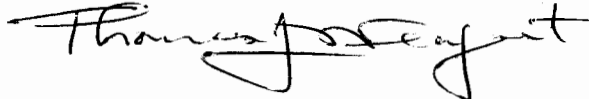
Dear Sir or Madam:

By letter dated July 18, 2016, Entergy Operations, Inc. (Entergy, the licensee) submitted a document titled "Alloy 600 Aging Management Program Plan," for Arkansas Nuclear One, Unit 2 (ANO-2) to the U.S. Nuclear Regulatory Commission (NRC) for review and approval. The licensee submitted the ANO-2 Alloy 600 Aging Management Program (AMP) Plan for NRC review and approval in accordance with license renewal Commitment No. 1, documented in NUREG-1828, "Safety Evaluation Report Related to the License Renewal of the Arkansas Nuclear One, Unit 2," Appendix A, dated June 2005. During the NRC staff's review of Entergy's ANO-2 license renewal application, the licensee provided the commitment to address the NRC staff's concerns regarding the licensee's plan to manage the aging effects of components fabricated from nickel-based alloys (i.e., Alloy 600, Alloy 690, and welds with Alloy 82/182 and Alloy 52/152 filler metals) in the reactor coolant system that are not addressed by the licensee's Reactor Vessel Head Penetration Inspection and Steam Generator Integrity Programs during the period of extended operation.

The NRC staff reviewed the information in the licensee's submittal and determined that the licensee has fulfilled Commitment No. 1 for license renewal and demonstrated that the Alloy 600 AMP Plan provides reasonable assurance that aging components under consideration will be adequately managed.

If you have any questions, please contact me at (301) 415-4037 or by e-mail at [Thomas.Wengert@nrc.gov](mailto:Thomas.Wengert@nrc.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "Thomas J. Wengert". The signature is fluid and cursive, with a prominent loop at the end of the last name.

Thomas J. Wengert, Senior Project Manager  
Plant Licensing Branch IV  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-368

Enclosure:  
Staff Assessment

cc w/encl: Distribution via Listserv



UNITED STATES  
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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

LICENSE RENEWAL COMMITMENT SUBMITTAL OF

NICKEL-BASED ALLOY AGING MANAGEMENT PROGRAM

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 2

DOCKET NO. 50-368

1.0 INTRODUCTION AND BACKGROUND

By letter dated July 18, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16200A131), Entergy Operations, Inc. (Entergy, the licensee), submitted a document titled "Alloy 600 Aging Management Program Plan," for Arkansas Nuclear One, Unit 2 (ANO-2) to the U.S. Nuclear Regulatory Commission (NRC) for review and approval.

The licensee submitted the ANO-2 Alloy 600 Aging Management Program (AMP) Plan for NRC review and approval in accordance with the license renewal commitment documented in NUREG-1828, "Safety Evaluation Report Related to the License Renewal of the Arkansas Nuclear One, Unit 2," dated June 2005 (ADAMS Accession No. ML051730233). During the license renewal of ANO-2, the licensee provided the license renewal commitment to address the NRC staff's concerns related to how the licensee would manage the aging effects of components fabricated from nickel-based alloys (i.e., Alloy 600, Alloy 690, and welds with Alloy 82/182 and Alloy 52/152 filler metals) in the reactor coolant system that are not addressed by the licensee's Reactor Vessel Head Penetration Inspection and Steam Generator Integrity Programs during the period of extended operation (PEO).

At the time of license renewal for ANO-2, there were multiple initiatives by industry and NRC for managing nickel-based alloy cracking due to primary water stress corrosion cracking (PWSCC) in reactor pressure boundary components of pressurized water reactors (PWRs). Since ANO-2 is a PWR, and PWSCC of its nickel-based alloys could be applicable to its reactor pressure boundary components during the PEO, the licensee made a commitment to resubmit its Alloy 600 AMP for NRC review and approval prior to entering the PEO.

2.0 REGULATORY EVALUATION

By letter dated October 14, 2003 (ADAMS Accession No. ML032890492), Entergy submitted a license renewal application (LRA) for ANO-2. Title 10 of the *Code of Federal Regulations* (10 CFR) Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants,"

addresses the requirements for plant license renewal. Pursuant to 10 CFR 54.21, "Contents of application-technical information," each application for license renewal must contain an integrated plant assessment (IPA).

The plant-specific IPA must identify and list those structures and components subject to an aging management review and demonstrate that the effects of aging (e.g., cracking, loss of material, loss of fracture toughness, dimensional changes, and loss of preload) will be adequately managed so that their intended functions will be maintained consistent with the current licensing basis (CLB) for the PEO as required by 10 CFR 54.29(a). In addition, 10 CFR 54.21(d) requires that the final safety analysis report (FSAR) supplement for the facility contain a summary description of AMPs and activities for managing the effects of aging, as well as time-limited aging analyses for the PEO.

By letter dated June 30, 2005 (ADAMS Accession No. ML051800757), the NRC issued Renewed Facility Operating License No. NPF-6 for ANO-2. The technical basis for the NRC staff's review and issuance of the renewed operating facility license is documented by NUREG-1828. As stated above, NUREG-1828 also documents the licensee's commitment regarding future activities to be completed by the licensee related to the aging management of nickel alloy components in the reactor coolant system, which are not addressed by the licensee's Reactor Vessel Head Penetration Inspection and the Steam Generator Integrity Programs.

Pursuant to 10 CFR 54.21(d), ANO-2 Safety Analysis Report, Section 18.1.1 includes a summary description of the licensee's Alloy 600 AMP. Additionally, License Condition 2.F of ANO-2 Renewed Facility Operating License No. NPF-6 states that ANO-2 shall complete certain future activities as described in its FSAR supplement, submitted pursuant to 10 CFR 54.21(d), prior to July 17, 2018 (i.e., the PEO).

During license renewal, the NRC staff reviewed the ANO-2 LRA in accordance with 10 CFR Part 54, and the guidance provided by NUREG-1800, "Standard Review Plan for the Review of License Renewal Applications for Nuclear Power Plants" (SRP-LR), dated July 2001 (ADAMS Accession Nos. ML012070391 and ML012070409). The latest revision of SRP-LR is NUREG-1800, Revision 2, dated December 2010 (ADAMS Accession No. ML103490036). As documented in Commitment No. 1 in NUREG-1828, Appendix A, the licensee committed to submit a description of its Alloy 600 AMP for NRC staff review and approval at least 24 months prior to ANO-2 entering its PEO. The PEO for ANO-2 will begin on July 18, 2018.

Based on the above, and subject to the following technical evaluation, the NRC staff concludes that the regulatory authority exists for the licensee to request and the NRC to review and approve the licensee's Alloy 600 AMP submittal for ANO-2. The scope of the staff's assessment is limited to the ANO-2 "Alloy 600 Aging Management Program," submitted by the licensee to satisfy the ANO-2 license renewal commitment.

### 3.0 TECHNICAL EVALUATION

#### 3.1 Summary of Technical Information Provided by the Licensee

In its submittal dated July 18, 2016, Entergy stated that, at the time of the license renewal of ANO-2, the license renewal guidance for AMPs was provided by NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," Revision 0, dated July 2001 (ADAMS Accession Nos. ML012060392, ML012060514, ML012060539, and ML012060521). The licensee also stated that PWSCC in Alloy 600 materials is a current license term issue and that interaction

between the NRC and the industry has been ongoing to develop a program to manage the effects of aging due to this mechanism. The licensee further stated that issues that are relevant to current plant operation are addressed by the existing regulatory process within the present license term, rather than deferred until the PEO. In addition, the licensee stated that the existing regulatory process provides assurance that aging effects caused by PWSCC of Alloy 600 materials are adequately managed during the PEO.

The licensee stated that its Alloy 600 AMP manages aging effects of nickel alloy components in the reactor coolant system that are not addressed by its Reactor Vessel Head Penetration Inspection and Steam Generator Integrity Programs. The licensee further stated that the program detects PWSCC by using the examination and inspection requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components."

The licensee's submittal addressed 10 elements of the ANO-2 Alloy 600 AMP that are used to describe the AMP. These 10 attributes align with the 10 program elements in NUREG-1800, Revision 2, SRP-LR, Section A.1, Table A.1-1, used to describe an acceptable AMP. The licensee indicated that the program manages aging in accordance with current applicable inservice inspection requirements, including ASME Code Cases N-722-1, "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials, Section XI, Division 1"; N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds Section XI, Division 1"; and N-770-1, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities Section XI, Division 1," subject to the conditions stipulated in 10 CFR 50.55a.

### 3.2 NRC Staff Assessment

During its prior review of the ANO-2 LRA, the NRC staff evaluated ANO-2 Alloy 600 AMP elements 1 through 10 of the licensee's program with respect to the 10 program elements recommended in NUREG-1801. Subsequently, the NRC staff found the program acceptable, as documented in Section 3.0.3.3.1 of NUREG-1828. Additionally, the staff's previous review of the "corrective actions," "confirmation process," and "administrative controls," program elements 7, 8 and 9, respectively, is documented in Section 3.0.4 of NUREG-1828. As discussed above, PWSCC of nickel alloys was an emerging issue for PWRs at the time of the license renewal of ANO-2. In response to the staff's requests for additional information on this emerging issue during license renewal, the licensee provided a commitment to submit the ANO-2, Alloy 600 AMP for NRC review and approval at least 24 months prior to ANO-2 entering the PEO (ADAMS Accession No. ML042660110).

On June 21, 2011, subsequent to the issuance of the renewed operating license to ANO-2, the NRC updated 10 CFR 50.55a to require all licensees of PWRs to augment their inservice inspection programs by implementing ASME Code Case N-722-1 and ASME Code Case N-770-1 with certain conditions.

As discussed above, 10 CFR 50.55a specifies augmented inspection requirements for Alloy 600/82/182 components. These augmented inspections include the implementation of ASME Code Cases N-722-1, N-729-1, and N-770-1, subject to the conditions in 10 CFR 50.55a.

In its review, the NRC staff confirmed that the licensee's program relies on the augmented inspection requirements specified in 10 CFR 50.55a. The staff also noted that the licensee's program, which requires the performance of inservice inspection activities in accordance with 10 CFR 50.55a, is also consistent with the current guidance provided in NUREG-1801, Revision 2.

In addition, the NRC staff evaluated the overall effectiveness of the licensee's program for managing the aging effects of its nickel-based alloy components during the PEO, as described below. Specifically, the staff reviewed the operating experience of the plant's nickel alloy components, including inspection results, to evaluate whether the program would maintain the intended functions of these components, consistent with the CLB during the PEO, in accordance with 10 CFR 54.21(a)(3).

The NRC staff noted that the licensee has replaced some nickel alloy components, performed full structural weld overlays, and has performed other mitigating activities at ANO-2. In addition, the licensee stated that plant-specific and industry operating experience suggest that mitigating activities and inspections performed in accordance with the program have been effective in identifying PWSCC.

The NRC staff reviewed this information against the acceptance criteria in SRP-LR Section A.1.2.3.10, which states in part that currently available operating experience applicable to the program, as well as consideration of future operating experience relating to the AMP, should be discussed. SRP-LR Section A.1.2.3.10 also states that the information on the operating experience should provide objective experience to support a conclusion that the program will adequately manage the effects of aging during the PEO.

The NRC staff reviewed the operating experience provided in the licensee's submittal and did not identify any operating experience that would indicate that the licensee should consider modifying its inspection program. Additionally, as part of its review of the "operating experience" program element, the staff performed an independent search of licensee event reports, event notifications, and inservice inspection summary reports for ANO-2 dating back to May of 2005. From this independent review, the staff determined that the operating experience provided by the licensee was bounded by known industry operating experience (e.g., no previously unknown or recurring aging effects were identified by the licensee or NRC staff).

Based on its review of the ANO-2 Alloy 600 AMP, the NRC staff concludes that the licensee has appropriately evaluated plant-specific and industry operating experience. The staff confirmed that the "operating experience" program element satisfies the criteria in SRP-LR Section A.1.2.3.10 and, therefore, the staff concludes that it is acceptable.

#### 4.0 CONCLUSION

The NRC staff reviewed Entergy's submittal dated July 18, 2016, to determine whether it contains sufficient information to demonstrate fulfillment of Entergy's license renewal commitment regarding the ANO-2 Alloy 600 AMP, and the acceptability of the proposed AMP. Based on its review, the staff concludes that there is reasonable assurance that the licensee will adequately manage the aging effects of the nickel alloy components within the scope of the Alloy 600 AMP, consistent with the inservice inspection requirements specified in 10 CFR 50.55a. Accordingly, the NRC staff approves the ANO-2 Alloy 600 AMP and concludes that the licensee's implementation of the program fulfills Commitment No. 1 for license renewal related to the ANO-2 Alloy 600 AMP.

Principal Contributor: R. Kalikian, NRR/DE

Date: June 28, 2017

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**ADAMS Accession No.: ML17167A083**

**\*via e-mail**

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