December 8, 2006

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

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 1 - RE: REQUEST FOR RELIEF FROM THE REQUIREMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE (TAC NO. MD1398)

Dear Mr. Forbes:

By letter dated April 24, 2006, Entergy Operations, Inc. (Entergy), submitted a request for the use of alternatives to certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, requirements at Arkansas Nuclear One, Unit 1 (ANO-1).

Subparagraph IWA-2430(d) of the ASME Code, Section XI states, “For components inspected under Program B, each of the inspection intervals may be extended or decreased by as much as 1 year. Adjustments shall not cause successive intervals to be altered by more than 1 year from the original pattern of the intervals." In accordance with this ASME Code-allowed extension, Entergy has opted to use this provision, thus extending the end of the third 10-year inservice inspection (ISI) interval to May 31, 2008. However, Entergy proposes to perform the third ISI reactor pressure vessel weld examination during the fall 2008 refueling outage, which is approximately 180 days beyond the ASME Code-allowed 1-year extension. Therefore, Entergy has submitted Request for Alternative ANO-ISI-005, which proposes an additional extension to the third 10-year ISI interval to the fall 2008 refueling outage.

Based on the staff’s review of the information provided by the licensee in its letter dated April 24, 2006, authorizing the proposed alternative is justified on the basis that it would provide an acceptable level of quality and safety. Therefore, the staff authorizes the proposed alternative pursuant to paragraph 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations* for the third 10-year ISI interval at ANO-1. The proposed alternative is authorized until the end of the ANO-1 fall 2008 refueling outage.

The staff's safety evaluation is enclosed.

Sincerely,

/RA/

David Terao, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosure: Safety Evaluation

cc w/encl: See next page

The staff's safety evaluation is enclosed.

Sincerely,

/RA/

David Terao, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
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OFFICIAL AGENCY RECORD

Arkansas Nuclear One

cc:
Executive Vice President
& Chief Operating Officer
Entergy Operations, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

General Manager Plant
Operations
Entergy Operations, Inc.
Arkansas Nuclear One
1448 S. R. 333
Russellville, AR 72802

Director, Nuclear Safety Assurance
Entergy Operations, Inc.
Arkansas Nuclear One
1448 S. R. 333
Russellville, AR 72802

Manager, Licensing
Entergy Operations, Inc.
Arkansas Nuclear One
1448 S. R. 333
Russellville, AR 72802

Director, Nuclear Safety & Licensing
Entergy Operations, Inc.
1340 Echelon Parkway
Jackson, MS 39213-8298

Section Chief, Division of Health
Radiation Control Section
Arkansas Department of Health and
Human Services
4815 West Markham Street, Slot 30
Little Rock, AR 72205-3867

Section Chief, Division of Health
Emergency Management Section
Arkansas Department of Health and
Human Services
4815 West Markham Street, Slot 30
Little Rock, AR 72205-3867

Senior Resident Inspector
U.S. Nuclear Regulatory Commission
P. O. Box 310
London, AR 72847

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

County Judge of Pope County
Pope County Courthouse
Russellville, AR 72801

Vice President, Operations Support
Entergy Operations, Inc.
P. O. Box 31995
Jackson, MS 39286-1995

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

THIRD 10-YEAR INSERVICE INSPECTION INTERVAL

REQUEST FOR ALTERNATIVE ANO-ISI-005 TO THE AMERICAN SOCIETY OF

MECHANICAL ENGINEERS CODE, SECTION XI

REACTOR PRESSURE VESSEL WELD EXAMINATION

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 1

DOCKET NUMBER 50-313

1.0 INTRODUCTION

By letter dated April 24, 2006 (Reference 1), Entergy Operations, Inc. (the licensee, Entergy), submitted Request for Alternative ANO-ISI-005, wherein the licensee has specifically requested an extension to the Arkansas Nuclear One, Unit 1 (ANO-1) third 10-year inservice inspection (ISI) interval to defer the specific reactor pressure vessel (RPV) weld examinations.

1.1 Background

Subparagraph IWA-2430(d) of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) states, "For components inspected under Program B, each of the inspection intervals may be extended or decreased by as much as 1 year. Adjustments shall not cause successive intervals to be altered by more than 1 year from the original pattern of the intervals." In accordance with this ASME Code-allowed extension, Entergy has opted to use this provision, thus extending the end of the third 10-year ISI interval to May 31, 2008. However, Entergy proposes to perform the third ISI RPV weld examination during the fall 2008 refueling outage, which is approximately 180 days beyond the ASME Code-allowed 1-year extension. Therefore, Entergy has submitted Request for Alternative ANO-ISI-005, which proposes an additional extension to the third 10-year ISI interval to the fall 2008 refueling outage.

2.0 REGULATORY REQUIREMENTS

ISI of the ASME Code Class 1, 2, and 3 components is performed in accordance with Section XI of the ASME Code and applicable addenda as required by Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g), except where specific relief has been granted by the

Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 50.55a(g)(6)(i). The code of record for ANO-1's third 10-year ISI interval, which began June 1, 1997, and ends May 31, 2007, is the 1992 edition of ASME Code, Section XI. Subsection IWA-2430(a) of this edition of the ASME Code states: "[t]he inservice examinations and system pressure tests required by IWB, IWC, IWD, and IWE shall be completed during each of the inspection intervals for the service lifetime of the power unit. The inspections shall be performed in accordance with the schedules of Inspection Program A of IWA-2431, or, optionally, Inspection Program B of IWA-2432." Subsection IWB-2410 of this edition of the ASME Code states: "Inservice examination and system pressure tests may be performed during the plant outages such as refueling shutdowns or maintenance shutdowns. ANO-1 has adopted Inspection Program B of IWA-2432 per the inspection scheduling requirements of IWB-2412.

Subsection IWA-2430(d) of the relevant ASME Code states, "[f]or components inspected under Program B, each of the inspection intervals may be extended or decreased by as much as 1 year. Adjustments shall not cause successive intervals to be altered by more than 1 year from the original pattern of the intervals." In accordance with this ASME Code-allowed extension, Entergy has opted to use this provision, thus extending the end of the third 10-year ISI interval to May 31, 2008. However, Entergy proposes to perform the third ISI RPV weld examination during the fall 2008 refueling outage, which is approximately 180 days beyond the ASME Code-allowed 1-year extension. Therefore, Entergy has submitted Request for Alternative ANO-ISI-005, which proposes an additional extension to the third 10-year ISI interval to the fall 2008 refueling outage.

3.0 TECHNICAL EVALUATION

3.1 Components for which Relief is Requested

The affected component is the ANO-1 RPV; specifically, the following ASME Code, Section XI, Examination Categories and Item Numbers covering examinations of the RPV. These Examination Categories and Item Numbers are from Table IWB-2500-1 of the 1992 Edition of ASME Code, Section XI.

Examination Category	Item Number	Description
B-A	B1.11	Circumferential Shell Welds
B-A	B1.12	Longitudinal Shell Welds
B-A	B1.21	Circumferential Head Welds
B-A	B1.22	Meridional Shell Welds
B-A	B1.30	Shell-to-Flange Weld
B-A	B1.51	Beltline Region Repair Welds
B-D	B3.90	Nozzle-to-Vessel Welds
B-D	B3.100	Nozzle Inner Radius Areas

Examination Category	Item Number	Description
B-J	B9.11	Circumferential Welds in Piping (only for the reactor vessel inlet and outlet nozzle to piping welds)

3.2 Basis for Proposed Alternative

The requirements for a technical basis to extend the third 10-year RPV ISI interval to the end of the fall 2008 refueling outage for the identical inspections are contained in a letter from R. Gramm of the NRC to G. Bischoff of the Westinghouse Owners Group, dated January 27, 2005, which identifies the five areas that form the basis for the technical justification. Entergy has addressed all five technical areas in Reference 1 as follows:

A. Plant-specific RPV ISI history

B. Pressurized-water reactor (PWR) RPV ISI history

C. Degradation mechanisms in the RPV

D. Material condition of the RPV relative to embrittlement

E. Operational experience relative to RPV structural integrity challenging events

ANO-1 is currently in its third 10-year ISI interval for the RPV weld examinations, which began June 1, 1997, and ends May 31, 2007. The preservice inspection and one ISI have been performed on the Examination Category B-A, B-D, and B-J welds to date for ANO-1.

These examinations, which were performed in accordance with ASME Code, Section XI, 1992 Edition, and Regulatory Guide (RG) 1.150 achieved essentially 100-percent coverage and no reportable indications were found. The licensee provided tables in its letter showing a detailed inspection history for the welds and claims that due to the examination method used and the coverage obtained on the welds, any significant flaws that could challenge RPV integrity would be detected by the preservice and inservice inspections.

Per the requirements of the technical basis as given in Reference 2, the licensee conducted a survey of the RPV ISI history for 14 PWRs representing 301 total years of service and included RPVs fabricated by various vendors. None of the 14 plants surveyed reported any findings during examinations of Category B-A, B-D, and B-J welds of their RPVs. All PWR plants except one have performed their first 10-year ISI of the subject welds and no surface-breaking or unacceptable near-surface flaws have been reported in any of these inspections performed per the requirements of RG 1.150 or ASME Code, Section XI, Appendix VIII.

The licensee has also conducted an assessment of the possible RPV degradation mechanisms. According to the licensee, the only currently known degradation mechanism for the subject welds is fatigue due to thermal and mechanical cycling from operational transients. Based on

flaw growth simulation studies, Entergy identified the cooldown transient as having the greatest contribution to flaw growth. Based on the low likelihood of more than one or two cooldown transients occurring and the relatively low fatigue usage factors for the welds in the subject examinations, the licensee concluded that any flaw growth due to fatigue is expected to be inherently small.

Entergy noted that from a loading perspective, the most severe operational challenge to RPV integrity is due to pressurized-thermal shock (PTS) events. The licensee stated that the ANO-1 RPV weld material is below, and will remain below, the PTS screening criteria (according to 10 CFR 50.61) during the extension period.

Entergy has stated that ANO-1 has implemented emergency operating procedures (EOPs) and operator training to provide assurance that the likelihood of a severe PTS event over the next operating cycle is very low. The operator training stresses fundamental EOP coping strategies in both the classroom and simulator forums. Included in the curriculum are procedure entry conditions, floating steps, fundamental rules, mitigation strategies, time-critical actions, and background information from the basis documents. Critical tasks chosen to be of the utmost importance typically include the preservation and protection of fission product barriers. Entergy characterized ANO-1's response to three scenarios (developed by the NRC staff during its PTS risk reevaluation work) that are believed to be the most likely scenarios, which could cause a PTS event that would challenge significant flaws in the RPV welds. The three scenarios are initiated by the following infrequent events:

(1) Any transient with reactor trip followed by one stuck-open pressurizer safety/relief valve (PSRV) that recloses after about 1 hour. Severe PTS events also require the failure to properly control high-head injection.

Entergy stated that when reactor coolant system (RCS) pressure continues to decrease following a trip because of a PSRV opening and sticking open, engineered safeguard actuation system (ESAS) actuation would occur and the operators would enter the ESAS procedure. While the PSRV remains open, the ESAS procedure provides guidance to control RCS pressure low within the limits of the RCS pressure-temperature (PT) limit curve, provided sub-cooled margin is adequate. Assuming the PSRV eventually closes, operators would recognize rising RCS pressure, validate that high-pressure injection (HPI) throttling criteria had been met, and throttle or secure HPI to prevent system repressurization.

(2) Large loss of secondary steam from steamline break or stuck-open atmospheric dump valves. Severe PTS events also require the failure to properly control auxiliary feedwater flow rate and destination (e.g., away from the affected steam generator) and failure to properly control HPI.
Entergy stated that decreasing steam generator pressure following a trip would result in main steamline isolation (MSLI) and emergency feedwater (EFW) actuation. These systems would function to isolate the affected steam generator and provide EFW to the unaffected steam generator. Entergy identified the procedure that provides guidance to the operators for verifying proper MSLI and EFW response including contingency actions to manually control the systems in the event of system or component

malfunction. Energy stated that operators would transition to an overcooling procedure which directs initiation of HPI to make up for RCS inventory shrinkage. The procedure directs the operator to stabilize RCS temperature using the cooling available by steaming the unaffected steam generator and provides direction to secure HPI, provided RCS inventory is satisfactory.

(3) Loss-of-coolant accidents for piping with nominal diameters ranging from 4 to 9 inches. Severity of a PTS event depends on the break location (the worst location appears to be in the pressurizer surge line) and the primary injection system's flow rate and water temperature.

Entergy stated that ANO-1 EOPs are symptom-based and the operators would follow the same procedures for all RCS break sizes. This procedure provides guidance to bound all break spectrums to maintain RCS pressure and temperature within the limits of the applicable PT limit curves.

3.3 Staff Evaluation

Entergy summarized prior ISI examinations performed on the RPV welds for ANO-1. All of the subject welds have been examined with no indications reported. The fundamental purpose of performing RPV weld ISI examinations is to detect and size flaws, hence predicting subsequent flaw growth before the flaws grow to the critical dimensions prerequisite of failure. Although ultrasonic examination technology has improved over the past decades, the geometry and materials involved in RPV weld examinations are such that these exams have not been particularly challenging from an inspection-technology perspective. Therefore, the staff agrees with Entergy's qualitative assessment that the prior examinations were of sufficient quality to identify any significant flaws that would challenge RPV integrity and that no significant flaws have been identified.

The licensee discussed the population of all PWRs and indicated that no surface-breaking flaws have been discovered and, for a population of 14 plants that were reviewed in detail, no reportable indications were identified in any of the RPV welds. Therefore, the staff concludes that the fleet ISI experience and the ISI experience specific to ANO-1 is consistent with the Entergy evaluation that there is a low probability of surface-breaking flaws propagating due to fatigue.

Entergy indicated that fatigue is the only operative mechanism that could have caused flaws to either initiate or grow in the welds during the period since the previous inspection. The staff concludes that corrosion, stress-corrosion cracking, and other forms of degradation due to the material's interaction with its chemical environment, are not active degradation mechanisms for the RPV welds. This is because the RPV forgings and welds are separated from the reactor coolant by a layer of corrosion-resistant cladding. Even if the cladding was breached (for example due to an original fabrication flaw in the cladding), the coolant water chemistry is controlled such that oxygen and other aggressive contaminants are maintained at very low levels so that the coolant is not aggressive to the ferritic material. Furthermore, the welds have not been subjected to a history of abnormal operational loading events, so mechanical overload has not been an active flaw initiation or propagation mechanism. Therefore, the staff agrees

with the conclusion that fatigue is the only likely operative mechanism that could have created or propagated flaws since the date the previous ISI examinations were performed.

The licensee states that the fatigue usage factors for these RPV welds will be much less than the ASME Code design limit of 1.0 after 40 years of operation, and that the most severe fatigue transient would be the cooldown. The staff agrees that it is unlikely that more than one or two of these cooldown events would occur during the requested extension period of the licensee's proposed alternative. In addition, the staff estimates that any flaw growth due to normal operational transients during the period since the last ISI examination would likely be very minimal.

Entergy provided the unirradiated nil-ductility transition reference temperature (RT_{NDT}) values for each of the RPV beltline materials for ANO-1, and provided the PTS reference temperature (RT_{PTS}) values to facilitate assessment of the effects of neutron irradiation on these beltline materials. Section 50.61 of 10 CFR currently provides PTS screening criteria of RT_{PTS} equal to 270 degrees Fahrenheit (°F) for plates and axial welds and RT_{PTS} equal to 300 °F for circumferential welds. Based on current projections, the licensee finds that the upper/lower shell circumferential weld WF-112 is the most limiting material for ANO-1. The projected RT_{PTS} value of 236.7 °F at 32 effective full-power years (EFPY) for this material is well below the PTS screening criteria and even at the end of license renewal (48 EFPY) the projected RT_{PTS} value of 278 °F will be below the 300 °F screening criteria. Furthermore, it is recognized by the NRC and industry that a large amount of conservatism exists in the current PTS screening criteria as evidenced in the NRC memorandum, "Technical Basis for Revision of the Pressurized Thermal Shock (PTS) Screening Criteria in the PTS Rule (10 CFR 50.61)," dated December 31, 2002 (Reference 3). Based on the beltline material data, existing PTS criteria and the known conservatism of the current PTS rule, it is clear that ANO-1 will remain well below the PTS screening criteria during the extension period. Therefore, the staff concludes that complying with 10 CFR 50.61 is sufficient to demonstrate that the probability of RPV failure due to a PTS event is acceptably low.

The PTS risk associated with operation during any time interval is the product of the likelihood that a significant flaw exists and the likelihood that a PTS event occurs during the interval, which would challenge the flaw. An increased risk associated with the requested extension arises from the potential existence of a significant flaw that would have been detected and repaired during the inspection at the end of the original interval. With an extended interval, this flaw would continue to be vulnerable to a severe PTS event during the period the inspection interval is extended. Instead of attempting to estimate this increased risk, Entergy concluded that the low probability of a PTS event during the requested extension combined with the low probability of a flaw existing in the RPV results in a very small probability of RPV failure due to PTS.

Entergy identified the EOPs that would be used to respond to the three scenarios (developed by the NRC staff during its PTS risk reevaluation work) that are believed to be the most likely scenarios that could cause a PTS event, which would challenge significant flaws in the RPV welds. The staff concurs that the likelihood of any of these initiating events occurring during the extension period is low. Furthermore, existing plant procedures and material properties can

mitigate the severity of, or the affects of, the PTS event that would be caused by these initiating events.

In summary, the staff has reviewed Entergy's evaluation and makes the following conclusions:

- Previous RPV ISI results were of sufficient quality to provide useful test results.
- Previous ISI examinations did not identify any indications.
- The RPV welds are not subjected to stresses or corrosive conditions that would create new flaws or cause old flaws to grow.
- Industry experience with ISI examinations of similar welds has yielded similar results; there are no known significant RPV flaws.
- The most severe degradation mode that is expected to be operative is fatigue, and the most severe operational event with respect to fatigue is cooldown, an event expected to occur only one or two times during the requested extension period. Therefore, growth of flaws due to fatigue would be minimal during the period since the previous ISI examination and would likely be very small during the proposed extension period.
- The RPV material has sufficient toughness to be acceptable with respect to PTS, as determined by Entergy's compliance with the requirements of 10 CFR 50.61.
- The likelihood of a severe PTS event occurring during the proposed extension period is low.

Accordingly, the staff concurs with Entergy's qualitative assessment that the ANO-1 welds have a low likelihood of having significant flaws and experiencing a severe PTS event during the proposed extension period. The staff finds that the risk associated with the one-cycle extension of the examination interval is sufficiently small that it need not be quantified to support the conclusion that this alternative continues to provide an acceptable level of quality and safety. Operation of the RPV for an additional cycle, without performing the ISI examination of the subject welds, would not significantly increase the risk of flaw growth due to fatigue or to RPV failure due to PTS.

4.0 CONCLUSION

On the basis of the above evaluation, the NRC staff concludes that Entergy's proposed alternative provides an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the proposed alternative for the third 10-year ISI interval at ANO-1. This proposed alternative is authorized until the end of the fall 2008 refueling outage for ANO-1 (1R21). All other requirements of the ASME Code for which relief has not been specifically requested remain applicable including third-party review by the Authorized Nuclear Inservice Inspector.

5.0 REFERENCES

1. Entergy Operations, Inc., letter dated April 24, 2006, from F.G. Burford (Acting Director, Nuclear Safety and Licensing) to U.S. Nuclear Regulatory Commission Document Control Desk, "Request for Alternative ANO-ISI-005 Proposed Alternative to Extend the Third Inservice Inspection Interval for Reactor Vessel Weld Examinations," Agencywide Documents Access and Management System (ADAMS) Accession No. ML061230064.

2. R. Gramm of the NRC to G. Bischoff of the Westinghouse Owners Group, "Summary of Teleconference with the Westinghouse Owners Group Regarding Potential One Cycle Relief of Reactor Pressure Vessel Shell Weld Inspections at Pressurized Water Reactors Related to WCAP-16168-NP, 'Risk-Informed Extension of Reactor Vessel In-Service Inspection Intervals,' " dated January 27, 2005, ADAMS Accession No. ML050250410.

3. NRC Memorandum, A. Thadani to S. Collins, "Technical Basis for Revision of the Pressurized Thermal Shock (PTS) Screening Criteria in the PTS Rule (10 CFR 50.61)," dated December 31, 2002, ADAMS Accession No. ML030090629.

Principal Contributor: M. Mitchell

Date: December 8, 2006