August 22, 2006

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

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 2, REQUEST FOR RELAXATION FROM FIRST REVISED NUCLEAR REGULATORY COMMISSION ORDER EA-03-009, DATED FEBRUARY 20, 2004, EXAMINATION REQUIREMENT FOR REACTOR PRESSURE VESSEL HEAD (TAC NO. MD1396)

Dear Mr. Forbes:

By letter dated April 27, 2006, Entergy Operations, Inc., requested relaxation to implement an alternative to the requirements of Section IV.C(5)(a) of the First Revised U.S. Nuclear Regulatory Commission (NRC) Order EA-03-009 (Order) for the reactor pressure vessel head (RPVH) at Arkansas Nuclear One, Unit 2 (ANO-2). You referenced supporting information previously provided in letters dated May 8, 2003, and March 30, 2006.

For ANO-2, and similar plants determined to have a high susceptibility to primary water stress corrosion cracking, in accordance with Sections IV.A and IV.B of the Order, Section IV.C(1) requires a bare metal visual examination. This examination consists of 100 percent of the RPVH surface, in accordance with Section IV.C(5)(a) of the Order, to be performed each outage.

The NRC staff has reviewed your request and concludes that your proposed alternative inspection of the ANO-2, RPVH, as conditioned, provides reasonable assurance of the structural integrity of the RPVH. Further inspection of the RPVH in accordance with Section IV.C(5)(a), of the Order dated February 20, 2004, would result in hardship without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV.F, of the Order, the staff authorizes the proposed alternative inspection as stated in the enclosed safety evaluation, for the 2R-18 refueling outage through to the end of Operating Cycle 18.

Be aware that when RPVH inspections are performed using the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) requirements, acceptance criteria, or

qualified personnel, those activities and all related activities fall within the jurisdiction of the ASME Code. Therefore, Order-related inspection activities may be subject to third party review, including those by the Authorized Nuclear Inservice Inspector.

Sincerely,

/RA/

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

Docket No. 50-368

Enclosure: Safety Evaluation

cc w/encl: See next page

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Sincerely,

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David Terao, Chief
Plant Licensing Branch IV
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Docket No. 50-368

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FIRST REVISED ORDER EA-03-009 RELAXATION REQUEST, ALTERNATE

EXAMINATION COVERAGE FOR REACTOR PRESSURE VESSEL HEAD

ARKANSAS NUCLEAR ONE, UNIT 2

ENTERGY OPERATIONS, INC.

DOCKET NUMBER 50-368

1.0 INTRODUCTION

The First Revised Nuclear Regulatory Commission (NRC) Order EA-03-009 (Order), issued on February 20, 2004 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML040220181), requires specific examinations of the top reactor pressure vessel head (RPVH) and vessel head penetration (VHP) nozzles of all pressurized-water reactor plants (PWRs). Section IV.F of the Order states that requests for relaxation of the Order associated with specific penetration nozzles will be evaluated by the staff using the procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers (ASME) Code in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3). Section IV.F of the Order states that a request for relaxation regarding inspection of specific nozzles shall address the following criteria:

> (1) the proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or
>
> (2) compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For Arkansas Nuclear One, Unit 2 (ANO-2), and similar plants determined to have a high susceptibility to primary water stress corrosion cracking (PWSCC) in accordance with Sections IV.A and IV.B of the Order, Section IV.C.(1) requires a bare metal visual examination (BMVE) of 100 percent of the RPVH surface in accordance with Section IV.C.(5)(a) of the Order to be performed each outage. Section IV.C.(5)(a) states:

> By letter dated April 27, 2006, Agencywide Documents Access and Management System (ADAMS) Accession No. ML061430340, Entergy Operations, Incorporated (Entergy, the licensee) requested relaxation to implement an alternative to the requirements of Section IV.C.(5)(a) of the Order for the RPVH at ANO-2. The licensee referenced supporting information previously provided in letters dated May 8, 2003

(ADAMS Accession No. ML031360395), and March 30, 2006 (ADAMS Accession No. ML061020064).

2.0 REGULATORY EVALUATION

The Order, issued on February 20, 2004, requires specific examinations of the RPVH and VHP nozzles of all PWRs. Section IV.F of the Order states that requests for relaxation of the Order associated with specific penetration nozzles will be evaluated by the NRC staff using the procedure for evaluating proposed alternatives to the ASME Code in accordance with 10 CFR 50.55a(a)(3). Section IV.F of the Order states that a request for relaxation regarding inspection of specific nozzles shall address the following criteria: (1) the proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or (2) compliance with this First Revised Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For ANO-2 and similar plants determined to have a high susceptibility to PWSCC in accordance with Sections IV.A and IV.B of the Order, the following inspections are required to be performed every refueling outage in accordance with Sections IV.C.(5)(a) and (b) of the Order:

(a) Bare metal visual examination [BMVE] of 100 percent of the RPV head [RPVH] surface (including 360E around each RPV head penetration nozzle [VHP]. For RPV heads with the surface obscured by support structure interferences which are located at RPV head elevations downslope from the outermost RPV head penetration, a bare metal visual inspection of no less than 95 percent of the RPV head surface may be performed provided that the examination shall include those areas of the RPV head upslope and downslope from the support structure interference to identify any evidence of boron or corrosive product. Should any evidence of boron or corrosive product be identified, the licensee shall examine the RPV head surface under the support structure to ensure that the RPV head is not degraded.

3.0 FIRST REVISED NRC ORDER EA-03-009 RELAXATION REQUEST FOR EXAMINATION COVERAGE FOR REACTOR PRESSURE VESSEL HEAD

3.1 First Revised Order Requirements for which Relaxation is Requested

Section IV.C of the Order requires, in part, that a BMVE of the RPVH in accordance with the requirements of Section IV.C.(5)(a) of the Order be performed every refueling outage for high susceptibility plants similar to ANO-2.

The licensee has requested relaxation from the requirements of Section IV.C.(5)(a) of the Order. The specific relaxation requested is identified below.

3.2 Licensee's Proposed Alternative

The licensee seeks relaxation from the Order such that in lieu of performing full BMVEs of the RPVH and around each of the upper RPVH penetrations, the licensee will perform RPVH visual inspections to the extent practical without lifting and removing the cooling shroud.

3.3 Licensee's Basis for Proposed Alternative

The configuration of the ANO-2 RPVH assembly is a unique design and involves significant hardship to disassemble and reassemble the cooling shroud and insulation package to perform a BMVE. A description of the configuration of the ANO-2 RPVH insulation and cooling shroud was provided to the NRC in an Entergy letter dated May 8, 2003, "Request for Relaxation from Section IV.C(1)(a) of the Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads (ADAMS Accession Number ML031360395)." Even though the insulation collars around the base of the control element drive mechanism (CEDM) nozzles had to be replaced in the spring 2005 refueling outage (2R17) to perform the BMVE, the general configuration remains the same as previously discussed in the May 8, 2003, letter.

There are limitations to conducting an RPVH BMVE due to the ANO-2, cooling shroud and insulation design. The insulation package rests directly in contact with the carbon steel surface of the upper RPVH, and consists of flexible insulation collars around each nozzle, with metal reflective insulation panels lowered onto the insulation collars. The metal reflective insulation panels rest directly on the surface of the head and entrap the flexible insulation collars such that they cannot be removed without first removing the metal reflective insulation panels. The cooling shroud forms a metal canopy over the insulation with only a few inches between the insulation and the shroud. Therefore, the cooling shroud must be removed to be able to remove the insulation panels. The cooling shroud is sandwiched between the insulation and the coil stacks for the CEDMs, as such, all 81 of the coil stacks and the 162 reed switch position transmitters (RSPTs) must be removed to be able to lift the cooling shroud for inspection of the RPVH. The ANO-2 cooling shroud and insulation package were not designed and constructed to be able to perform BMVEs of the head and were not designed to be removed from the top of the head. The removal of the cooling shroud creates a potential risk for equipment damage.

Cooling shroud disassembly poses significant difficulties and risks for equipment damage. The head lift rig is made up of three legs that are pinned to the reactor head lifting lugs at the bottom of the legs, and are structurally connected near the top by the work platform and the stud handling hoist monorail system. The legs are also structurally connected to each other by a lead shielding support structure just above the cooling shroud. The cooling shroud is attached to the legs at the top of the shroud by trunnions. The top of the legs provide a pin connection to which the lifting tripod attaches. The tripod provides a single point of attachment at the top center of the tripod that the polar crane connects to when lifting the RPVH. The height of the lift rig from its connection to the RPVH to the eye at the top of the tripod is approximately 33 feet. A pendulum type lift of this structure with the polar crane could experience unanticipated damage to the CEDM motor housings due to the lift rig tilting, swinging, or rotating.

As previously discussed, prior to lifting the cooling shroud, the coil stacks and RSPTs must be removed from the CEDM drive housings. After the shroud has been removed, the

17 interconnected insulation panels must be removed by unbuckling the interconnections and lifting each panel over the top of the CEDM motor housings. The flexible insulation collars then must be removed. These collars and panels are designed to fit into place with specific configurations around CEDM nozzles. Due to the close spacing of the CEDM nozzles, many of the insulation collars require special tooling to reach the collars for removal and replacement. The head lift rig, coil stacks, and RSPTs that have to be removed require special storage racks.

During the 2R17 outage, Entergy complied with Section IV.C(5)(a) of the NRC Order for conducting a BMVE. To accommodate future BMVEs with substantially reduced occupational radiological exposure, Entergy contracted with Westinghouse Electric Company to design a new cooling shroud and insulation package which was to be installed during the 2R17 outage. However, during the attempt to install the new cooling shroud during the 2R17 outage, it was discovered that critical dimensions in the as-built configuration of the original shroud were different than the design documentation. After several attempts to make field changes to the new cooling and insulation package, it was realized that the new shroud could not be installed. The old cooling shroud and insulation package had to be reinstalled after the BMVE was completed. Since the insulation collars were damaged during removal, new collars were installed around the CEDM and in-core instrumentation (ICI) penetrations. Further plans to install a new shroud and insulation package are being deferred until additional critical measurements can be taken for ensuring proper fit up.

From the evolutions performed during the 2R17 outage, the dose for the removal and reinstallation of the cooling shroud (including the RSPTs and coil stack removal) and insulation components was approximately 17 person-rem. The dose associated with performing the required BMVEs during the 2R17 outage was approximately 5 rem. Entergy expects to receive about 1 rem for the inspections performed through the cooling shroud doors in a newly designed cooling shroud. Therefore, Entergy estimates that relaxation from the full RPVH BMVE inspection requirements of the Order will save approximately 21rem during the 2R18 outage.

3.4 Licensee's Additional Actions

In lieu of performing a full BMVE of the RPVH and around each of the RPVH penetrations, Entergy will perform RPVH visual inspections to the extent practical without lifting and removing the cooling shroud. Even though the majority of the RPVH is not accessible for visual inspection, there are doors that are located in the cooling shroud (8 ICI nozzle and 6 alignment key doors) which provide limited viewing of the ICI nozzles and peripheral CEDM nozzles. Therefore, to help assure a comparable level of quality, Entergy will perform a visual inspection of the ICI nozzles and a BMVE of the accessible CEDM nozzles through the cooling shroud access doors during the 2R18 outage. This inspection will look for boric acid deposits that would be indicative of a penetration leak or that could potentially cause wastage of the RPV upper head. Entergy will perform a visual inspection of the RPVH upper head flange to identify potential boric acid deposits as well as performing inspections from the pressure-retaining components above the RPVH (in accordance with Section IV.D of the Order). Based on the inspections that will be conducted, Entergy is making the following commitment:

> Should there be evidence of [a] corrosive product coming from an inaccessible area on the RPVH, Entergy will notify the NRC of our findings and provide adequate information to the NRC staff that ensures that the RPVH is not degraded in the inaccessible area(s).

Entergy will perform volumetric examinations of 100 percent of the RPVH CEDM and ICI penetrations during the 2R18 outage in accordance with Section IV.C(5)(b)(i) of the Order and other approved Order relaxations. Per Section IV.C (5)(b)(i) of the Order, an assessment shall be made to determine if leakage has occurred into the annulus between the RPVH penetration nozzle and the RPVH low-alloy steel (leak path).

During the 2R18 outage, Entergy will conduct two augmented examinations. Entergy will inspect for wastage in the carbon steel of the RPVH using low frequency eddy current testing and will interrogate partially into the weld metal at the triple point (weld/butter/nozzle intersection) using ultrasonic testing to assure that no flaws have propagated at that point in the weld resulting in leakage.

If during the examinations discussed above, a potential, but indeterminate indication of a PWSCC flaw is found with any of the primary examination techniques, a surface examination of the J-groove weld utilizing liquid penetrant or eddy current will be conducted for the subject penetration.

4.0 STAFF EVALUATION

The NRC staff's review of this request was based on criterion (2) of Section IV.F of the Order, which states:

> Compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

ANO-2, is classified as a high susceptibility plant under the Order. As such, the licensee is required to perform a BMVE of the RPVH and a volumetric and/or surface examination of each VHP to the requirements of the Order.

Full BMVE coverage is not achievable at ANO-2, without unusual difficulty, which has not been identified by other licensees. The cooling shroud and insulation package was not designed to be removed and reinstalled from the top of the head to permit BMVEs without extensive modification. Entergy had contracted for a new redesigned cooling shroud and insulation package, but due to design problems, Entergy could not use the new unit at ANO-2, during the previous refueling outage, 2R-17. However, during the 2R-17 outage, the original cooling shroud and insulation package was removed, the bare metal surface of the RPVH was inspected, and the original unit was reinstalled. Additional removal and reinstallation during the upcoming ANO-2, outage, 2R-18, of the cooling shroud and insulation could potentially damage CEDM housings and the insulation without an effective means of repair.

The licensee's proposed alternative examination consists of a partial BMVE with additional augmented inspection activities to assure RPVH integrity. The licensee will perform an RPVH visual inspection to the extent practical without lifting and removing the cooling shroud. There are fourteen (14) doors in the cooling shroud through which the licensee will perform a BMVE

of the ICI nozzles and a visual inspection of the accessible outermost CEDM nozzles during the 2R-18 outage. The licensee will also perform visual inspections of the RPVH flange and pressure-retaining components above the RPVH to identify potential boric acid deposits in accordance with Section IV.D of the Order. Based on the inspections that will be conducted, the licensee makes the following commitment:

> Should there be evidence of [a] corrosive product coming from an inaccessible area on the RPV head, Entergy will notify the NRC of its findings and provide adequate information to the NRC staff that ensures that the RPV head is not degraded in the inaccessible area(s).

In addition to the required volumetric and/or surface examinations required by the Order, the licensee will conduct two augmented examinations. The licensee will inspect for wastage in the carbon steel of the RPVH using low frequency eddy current testing and interrogate partially into the weld metal at the triple point (weld/butter/nozzle intersection) using ultrasonic examination (UT) to assure that no flaws have propagated at that point in the weld resulting in leakage. Both of these augmented inspections were previously performed during the 2R-16 outage and through a letter dated October 9, 2003, from the NRC to Entergy, the NRC staff found while neither the UT triple point assessment or the low frequency eddy current testing are equivalent to the BMVE, the combined use of these two nondestructive examination techniques in lieu of a BMVE, as conditioned above, is sufficient to provide reasonable assurance of structural integrity of the RPVH.

The licensee also stated that if during the examinations discussed above, a potential, but indeterminate indication of a PWSCC flaw is found with any of the primary examination techniques, a surface examination of the J-groove weld utilizing liquid penetrant or eddy current would be conducted for the subject penetration.

The safety issues that are addressed by the Order are degradation (corrosion) of the low-alloy steel RPVH, reactor coolant pressure boundary integrity and ejection of VHP nozzles due to circumferential cracking of the nozzle above the J-groove weld. The licensee's proposed alternative inspection, as stated above, previous performance of a full BMVE of the RPVH head during the 2R-17 outage, and actions to be performed should evidence of a corrosive product or upon finding indications of PWSCC, provide reasonable assurance that these safety issues are addressed.

The licensee estimated that performing a bare metal examination under the current cooling shroud and insulation package would result in a 21 person-rem radiological dose exposure. Further, the licensee noted additional risk of possible damage to CEDM housings through the movement of the current cooling shroud and insulation package. Because of these hardships and the effectiveness of the licensee's proposed alternative examination, the NRC staff finds that requiring a 100 percent BMVE of the ANO-2 RPVH to be a significant hardship because of estimated radiation exposure without a compensating increase in the level of quality and safety.

Based upon the information above, the NRC staff finds that the licensee has demonstrated good cause for its proposed relaxation, and that the proposed alternative examination, as conditioned, is acceptable as it provides reasonable assurance of the structural integrity of the

RPVH. Further inspections to comply with the Order requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

4.0 CONCLUSION

The NRC staff concludes that the licensee's proposed alternative inspection of the ANO-2 RPVH, as conditioned, provides reasonable assurance of the structural integrity of the RPVH. Further inspection of the RPVH in accordance with Section IV.C.(5)(a) of the Order would result in hardship without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV.F, of the Order, the NRC staff authorizes the proposed alternative inspection as stated above at ANO-2, for the 2R18 refueling outage, through to the end of Operating Cycle 18 subject to the following condition:

> Should there be evidence of [a] corrosive product coming from an inaccessible area on the RPV head, Entergy will notify the NRC of its findings and provide adequate information to the NRC staff that ensures that the RPV head is not degraded in the inaccessible area(s).

Principal Contributor: J. Collins

Date: August 22, 2006

Arkansas Nuclear One

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

Director, Division of Radiation
Control and Emergency Management
Arkansas Department of Health
4815 West Markham Street, Slot 30
Little Rock, AR 72205-3867

Winston & Strawn
1700 K Street, N.W.
Washington, DC 20006-3817

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

Wise, Carter, Child & Caraway
P. O. Box 651
Jackson, MS 39205