April 15, 2002

Mr. Craig G. Anderson
Vice President, Operations ANO
Entergy Operations, Inc.
1448 S. R. 333
Russellville, AR 72801

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT NO. 2 - ISSUANCE OF AMENDMENT RE: REACTOR VESSEL PRESSURE-TEMPERATURE LIMITS AND EXEMPTION FROM THE REQUIREMENTS OF 10 CFR PART 50, SECTION 50.60(a) (TAC NOS. MB3301 AND MB3302)

Dear Mr. Anderson:

The Commission has issued the enclosed Amendment No. 242 to Facility Operating License No. NPF-6 for Arkansas Nuclear One, Unit No. 2 (ANO-2). This amendment consists of changes to the ANO-2 Technical Specifications (TSs) related to the reactor pressure vessel (RPV) operating limits at low temperatures in response to your application dated October 30, 2001, as supplemented by letters dated February 25 and March 13, 2002. The supplemental letters contained clarifying information and did not expand the scope of the Federal Register notice published on December 12, 2001 (66 FR 64294).

The amendment approves revised pressure-temperature (P-T) limits for the RPV to be applicable for a maximum of 32 effective full-power years of facility operation, and also approves additional TS restrictions for operation of the low temperature overpressure protection (LTOP) system. These changes were based, in part, on the use of the American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code (Code) Case N-641.

In addition, your letter dated October 30, 2001, as supplemented, requested an exemption from the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix G to allow application of ASME Code Case N-641. This Code case permits the use of an alternate reference fracture toughness for reactor vessel materials in determining the revised P-T curves, and LTOP system effective temperatures and allowable pressures to maintain operator flexibility and safety during heatup and cooldown conditions. Based upon review of the information provided, the staff has determined that application of ASME Code Case N-641 is acceptable for ANO-2. Accordingly, the staff, pursuant to 10 CFR 50.12(a), has issued an exemption from the requirements of Appendix G of 10 CFR Part 50 for ANO-2.

A copy of our related Safety Evaluation supporting the amendment, and a copy of the exemption are also enclosed. The exemption and the Notice of Issuance for the amendment will be included in the Commission's next biweekly *Federal Register* notice.

Sincerely,

/RA/

S. Patrick Sekerak, Project Manager, Section 1
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-368

Enclosures:
1. Amendment No. 242 to NPF-6
2. Safety Evaluation
3. Exemption

cc w/encls: See next page

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Sincerely,

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S. Patrick Sekerak, Project Manager, Section 1
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ENTERGY OPERATIONS, INC.

DOCKET NO. 50-368

ARKANSAS NUCLEAR ONE, UNIT NO. 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 242
License No. NPF-6

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Entergy Operations, Inc. (the licensee), dated October 30, 2001, as supplemented by letters dated February 25 and March 13, 2002, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this license amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-6 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendix A, as revised through Amendment No. 242, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. The license amendment is effective as of its date of issuance and shall be implemented within 60 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Robert A. Gramm, Chief, Section 1
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: April 15, 2002

ATTACHMENT TO LICENSE AMENDMENT NO. 242

FACILITY OPERATING LICENSE NO. NPF-6

DOCKET NO. 50-368

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
3/4 4-22	3/4 4-22
3/4 4-23	3/4 4-23
3/4 4-23a	3/4 4-23a
3/4 4-23b	3/4 4-23b
3/4 4-28	3/4 4-28
B 3/4 4-5	B 3/4 4-5
B 3/4 4-6	B 3/4 4-6
B 3/4 4-7	B 3/4 4-7
B 3/4 4-8	- - -
B 3/4 4-9	- - -
B 3/4 4-10	- - -
B 3/4 4-12	B 3/4 4-12

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 242 TO

FACILITY OPERATING LICENSE NO. NPF-6

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT NO. 2

DOCKET NO. 50-368

1.0 INTRODUCTION

By letter dated October 30, 2001 (Reference 1), as supplemented by letters dated February 25 and March 13, 2002, Entergy Operations, Inc. (EOI or the licensee), submitted a request for changes to the Arkansas Nuclear One, Unit No. 2 (ANO-2), Technical Specifications (TSs). The requested changes proposed revision of pressure-temperature (P-T) limits for the reactor pressure vessel (RPV) to be applicable for a maximum of 32 effective full-power years (EFPY) of facility operation, and also proposed additional TS restrictions for operation of the low temperature overpressure protection (LTOP) system for ANO-2.

The proposed TS changes include:

(1) Revise TS 3/4.4.9, "Pressure/Temperature Limits," by replacing Figures 3.4.2A, 3.4.2B, and 3.4.2C, which specify the reactor coolant system P-T limit curves for heatup, cooldown, and inservice hydrostatic testing, respectively, for 21 EFPY, with corresponding figures valid for 32 EFPY of facility operation.

(2) Revise TS 3.4.12, "Low Temperature Overpressure Protection (LTOP) System," with the addition of a restriction in the limiting conditions for operation (LCO), and an action requirement in the event of noncompliance with the LCO.

(3) Revise the associated TS Bases for the proposed TS changes.

The proposed changes to the P-T limits and LTOP system requirements were based, in part, on the use of American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code (Code) Case N-641. EOI requested an exemption from the requirements of Appendix G to Title 10 of the *Code of Federal Regulations* Part 50 (10 CFR Part 50), which mandates use of Appendix G to Section XI of the ASME Code for developing RPV P-T limits, in order to utilize ASME Code Case N-641.

2.0 BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) has established requirements in 10 CFR Part 50 to protect the integrity of the reactor coolant pressure boundary in nuclear power plants. The TS P-T limits for heatup, cooldown, inservice leak testing, and hydrostatic testing are established to define an acceptable operational region for prevention of nonductile failure of the reactor coolant system (RCS) pressure boundary, and to comply with the fracture toughness requirements of Appendix G to 10 CFR Part 50. These limits are calculated using the adjusted reference nil-ductility temperature, RT_{NDT}, corresponding to the limit beltline region material of the RPV. Because of the neutron embrittlement effect on the RPV material toughness, the RT_{NDT} increases as the reactor exposure to neutron fluence increases, and the P-T limits must be adjusted, as necessary, based on exposure evaluation.

The LTOP system, with appropriate relief capacity and setpoints, is designed to automatically prevent the reactor coolant pressure from exceeding the P-T limits, and prevent the RPV from being exposed to conditions of fast propagating brittle fracture. Once the system is enabled, no operator action is involved for the LTOP system to perform its intended pressure mitigation function. Whenever the P-T limits are revised, an evaluation is necessary to determine whether the LTOP enable temperature and setpoint remain acceptable.

The staff evaluates the P-T limit curves based on the following NRC regulations and guidance: Appendix G to 10 CFR Part 50; Generic Letter (GL) 88-11; GL 92-01, Revision 1; GL 92-01, Revision 1, Supplement 1; Regulatory Guide (RG) 1.99, Revision 2 (RG 1.99, Rev. 2); and Standard Review Plan (SRP) Section 5.3.2. GL 88-11 advised licensees that the staff would use RG 1.99, Rev. 2, to review P-T limit curves. RG 1.99, Rev. 2, contains methodologies for determining the increase in transition temperature and the decrease in upper-shelf energy resulting from neutron radiation. GL 92-01, Revision 1, requested that licensees submit their RPV data for their plants to the staff for review. GL 92-01, Revision 1, Supplement 1, requested that licensees provide and assess data from other licensees that could affect their RPV integrity evaluations. These data are used by the staff as the basis for the review of P-T limit curves. Appendix G to 10 CFR Part 50 requires that P-T limit curves for the RPV be at least as conservative as those obtained by applying the methodology of Appendix G to Section XI of the ASME Code, 1995 Edition through the 1996 Addenda.

SRP Section 5.3.2 provides an acceptable method of determining the P-T limit curves for ferritic materials in the beltline of the RPV based on the linear elastic fracture mechanics methodology of Appendix G to Section XI of the ASME Code. The basic parameter of this methodology is the stress intensity factor K_I, which is a function of the stress state and flaw configuration. Appendix G to Section XI of the ASME Code requires a safety factor of 2.0 on stress intensities resulting from reactor pressure during normal and transient operating conditions, and a safety factor of 1.5 for hydrostatic testing. Appendix G also requires a safety factor of 1.0 on stress intensities resulting from thermal loads for normal and transient operating conditions, as well as for hydrostatic testing. The methods of Appendix G postulate the existence of a sharp surface flaw in the RPV that is normal to the direction of the maximum stress (i.e., of axial orientation). This flaw is postulated to have a depth that is equal to 1/4 of the RPV beltline thickness and a length equal to 1.5 times the RPV beltline thickness. The critical locations in the RPV beltline region for calculating heatup and cooldown P-T curves are the 1/4 thickness (1/4T) and 3/4 thickness (3/4T) locations, which correspond to the maximum depth of the postulated inside surface and outside surface defects, respectively. The methodology found in Appendix G to Section XI of the ASME Code requires that licensees determine the adjusted reference temperature (ART or adjusted RT_{NDT}). The ART is defined as the sum of the initial (unirradiated) reference temperature (initial RT_{NDT}), the mean value of the adjustment in reference temperature caused by irradiation (ΔRT_{NDT}), and a margin (M) term.

The ΔRT_{NDT} is a product of a chemistry factor (CF) and a fluence factor. The CF is dependent upon the amount of copper and nickel in the material and may be determined from tables in RG 1.99, Rev. 2, or from surveillance data. The fluence factor is dependent upon the neutron fluence at the maximum postulated flaw depth. The M term is dependent upon whether the initial RT_{NDT} is a plant-specific or a generic value and whether the CF was determined using the tables in RG 1.99, Rev. 2, or surveillance data. The M term is used to account for uncertainties in the values of the initial RT_{NDT}, the copper and nickel contents, the fluence, and the calculational procedures. RG 1.99, Rev. 2, describes the methodology to be used in calculating the M term.

3.0 EVALUATION

3.1 Licensee Evaluation

The licensee requested, pursuant to 10 CFR 50.60(b), an exemption to use ASME Code Case N-641 as the basis for establishing the P-T limit curves. ASME Code Case N-641 permits application of the lower bound static initiation fracture toughness (K_{IC}) curve as the basis for establishing the P-T curves in lieu of using the lower bound crack arrest fracture toughness (K_{IA}) curve which is invoked by Appendix G to Section XI of the ASME Code. ASME Code Case N-641 further permits the use of a postulated circumferentially-oriented flaw for the evaluation of RPV circumferential welds in lieu of the axially-oriented flaw, which would be required by Appendix G to Section XI of the ASME Code. The other margins involved with the ASME Section XI, Appendix G process of determining P-T limit curves remained unchanged in the licensee's evaluation.

The licensee submitted ART calculations and P-T limit curves valid for up to 32 EFPY of facility operation. For the ANO-2 RPV, the licensee determined that the most limiting beltline material at the 1/4T and 3/4T locations was lower shell plate C-8010-1 fabricated using plate heat number C8161-2. The ART values for plate C-8010-1 at the 1/4T and 3/4T locations at 32 EFPY were 112.7 °F and 98.8 °F, respectively. The neutron fluences used in the ART calculations were 2.293×10^{19} n/cm^2 at the 1/4T location and 0.892×10^{18} n/cm^2 at the 3/4T location for 32 EFPY. The ΔRT_{NDT} values at the 1/4T and 3/4T locations at 32 EFPY are 66.7 °F and 52.8 °F, respectively, based on the use of the CF tables from RG 1.99, Rev. 2. The initial RT_{NDT} for plate C-8010-1 was 12 °F. The M term used in calculating the 1/4T and 3/4T ARTs for the limiting plate was 34 °F.

In addition, due to atypically low ART values associated with limiting plate C-8010-1, the licensee concluded that an evaluation of the material in the region of the reactor coolant inlet and outlet nozzle forgings would also affect the ANO-2 P-T limit curves. This could occur even though the nozzle forgings exhibit superior material properties (i.e., lower RT_{NDT} values) relative to the limiting beltline material because of the stress intensification due to the geometric discontinuity at the nozzle. Due to the specific geometries of the inlet and outlet nozzles, the licensee determined that the evaluation of the ANO-2 reactor coolant outlet nozzle forging with a RT_{NDT} value of 0 °F did affect the ANO-2 P-T limits. The licensee analyzed the integrity of the ANO-2 reactor coolant oulet nozzle forging using methods specified in Welding Research Council Bulletin 175, "PVRC [Pressure Vessel Research Committee] Recommendations on Toughness Requirements for Ferritic Materials." The use of the methods specified in Welding Research Council Bulletin 175 for analyzing the integrity of materials with geometric discontinuities for the purpose of establishing RPV P-T limits has been approved by the NRC staff for other licensees.

Regarding the detailed fracture mechanics evaluations performed to establish the proposed ANO-2 P-T limits, EOI submitted information on the throughwall temperature gradients resulting from heatup and cooldown transients and their determination of the applied stress intensity at the tip of the postulated 1/4T and 3/4T flaws, due to thermal loading (i.e., K_{IT}) in an enclosure to its February 25, 2002, supplemental letter. This information, along with knowledge of the applied stress intensity at the tip of the postulated 1/4T and 3/4T flaws due to pressure loads, and the material property information cited above for both the limiting beltline plate and outlet nozzle forging, permitted the staff to evaluate the acceptability of the proposed ANO-2 P-T limit curves.

3.2 NRC Staff Evaluation

3.2.1 Pressure-Temperature Limits

As mentioned above, the licensee requested an exemption to use ASME Code Case N-641 as the basis for establishing the P-T limit curves. Use of the K_{IC} curve in determining the lower bound fracture toughness curve in the development of P-T operating limits is more technically correct than use of the K_{IA} curve. The K_{IC} curve appropriately implements the use of static initiation fracture toughness behavior to evaluate the controlled heatup and cooldown process of a RPV. Likewise, the use of a postulated circumferentially-oriented flaw for the evaluation of RPV circumferential welds in lieu of the axially-oriented flaw is also more technically correct. The staff concluded that P-T curves, based on the K_{IC} fracture toughness curve and the postulated circumferentially-oriented flaw for the evaluation of RPV circumferential welds, as referenced by ASME Code Case N-641, will enhance overall plant safety by opening the P-T operating window with the greatest safety benefit in the region of low temperature operation. In addition, implementation of the proposed P-T curves, as defined by the technical basis supported by ASME Code Case N-641, does not significantly reduce the margin of safety.

The staff performed an independent calculation of the ART values for the limiting material using the methodology in RG 1.99, Rev. 2. Based on these calculations, the staff verified that the licensee's limiting beltline material for the ANO-2 RPV is lower shell plate C-8010-1. The staff's calculated ART values for the limiting material agreed with the licensee's calculated ART values.

The staff evaluated the licensee's P-T limit curves for acceptability by performing a finite set of check calculations based on information submitted by the licensee using the methodologies referenced in the ASME Code (as indicated by SRP 5.3.2) and in Welding Reseach Council Bulletin 175. The staff's calculations confirmed the licensee's determination that both the limiting RPV beltline plate and the outlet nozzle forging contributed to the definition of the ANO-2 P-T limit curves. Further, the staff compared information submitted by the licensee (particularly information related to the evaluation of thermal loading conditions) to information submitted previously for other, similar RPVs and determined that the information submitted by EOI for ANO-2 appeared to be consistent. The staff verified that the licensee's proposed P-T limits satisfy the requirements in Paragraph IV.A.2 of Appendix G of 10 CFR Part 50. Specifically, the staff concluded that the P-T limit curves submitted by the licensee appropriately accounted for the limiting conditions defined by the material properties of the limiting beltline plate and the outlet nozzle forging, and were as conservative as those which would be generated by the staff's application of the methodology specified in Appendix G to Section XI of the ASME Code, as modified by ASME Code Case N-641. Therefore, the staff determined that the licensee's proposed P-T limit curves were acceptable for operation of the ANO-2 RPV though 32 EFPY of operation.

In addition, Appendix G of 10 CFR Part 50 also imposes a minimum temperature at the closure head flange based on the reference temperature for the flange material. Section IV.A.2 of Appendix G states that when the pressure exceeds 20% of the preservice system hydrostatic test pressure, the temperature of the closure flange regions highly stressed by the bolt preload must exceed the reference temperature of the material in those regions by at least 160 °F for core critical operation; 120 °F for normal, non-critical core operation; and by 90 °F for hydrostatic pressure tests and leak tests. Based on the limiting flange RT_{NDT} of 30 °F for ANO-2, the staff has determined that the proposed P-T limits have satisfied the requirement for the closure flange region during all modes of normal operation and for hydrostatic pressure and leak testing.

3.2.2 Vessel Fluence

The proposed TS changes would extend applicability of the P-T limits curves in TS 3/4.4.9 from 21 EFPY to 32 EFPY. Because the P-T limits are established based on the expected vessel exposure to neutron fluence, the expected neutron fluence for 32 EFPY, including the proposed power uprate, must be determined.

Accompanying the license amendment request, the licensee provided Framatome ANP, Inc. (Framatome) topical reports BAW-2399 (Reference 2), which describes the vessel fluence calculation based on the specimen capsule W-104 removed during the ANO-2 fall 2000 outage, and BAW-2405 (Reference 3), which describes the calculation of the new P-T limits valid for 32 EFPY.

In the fall 2000, during the ANO-2 Cycle 14 refueling outage, vessel surveillance capsule W-104 was removed and measured. Reference 2 documents the results of the capsule W-104 analysis, and provides the basis for the revised fluence values for 32 EFPY and associated material properties. The capsule analysis was based on the NRC-approved methodology described in Framatome report BAW-2241-P-A (Reference 4). Therefore, the results of analysis and vessel fluence values for 32 EFPY are acceptable for use in the evaluation of pressurized thermal shock (PTS) and the P-T limits.

3.2.3 Pressurized Thermal Shock

The calculational procedure described in RG 1.99, Rev. 2, was used to calculate the CF and the 32 EFPY value of the PTS reference temperature, RT_{PTS}. The critical element is the lower shell plate C-8010-1 with an RT_{PTS} value of 119 °F, which is well within the limit of 270 °F required by 10 CFR 50.61. The calculated fluence value of 3.63×10^{19} n/cm^2 at 32 EFPY was used. This accounted for the proposed 7.5% power uprate for ANO-2 currently under separate review by the staff. The RT_{PTS} for 32 EFPY is acceptable, because the value of the fluence and the CF have been calculated with NRC-approved methods, and satisfy the requirements of 10 CFR 50.61.

3.2.4 Low Temperature Overpressure Protection System

LCO 3.4.12 specifies that the "LTOP system shall be OPERABLE with each SIT [safety injection tank] isolated that is pressurized to ≥ 300 psig, and:

a. Two LTOP relief valves with a lift setting of ≤ 430 psig, or

b. The Reactor Coolant System depressurized with an RCS vent path ≥ 6.38 square inches."

The applicability of this LCO is MODE 4 with reactor coolant temperature, $T_c \leq 220$ °F, MODE 5, MODE 6 with reactor vessel head in place.

The TS changes proposed in Reference 1 would (1) add an LCO restriction, which limits a maximum of one high pressure safety injection (HPSI) pump capable of injecting into the RCS when the LTOP system is enabled; and (2) add an action requirement that, with more than one HPSI pump capable of injecting into the RCS, immediately initiate action to verify a maximum of one HPSI pump capable of injecting into the RCS. In addition, in its supplemental letter of March 13, 2002 (Reference 5), the licensee, in response to a staff question, proposed to add a footnote in LCO 3.4.12 stating that: "when starting the first reactor coolant pump, the pressurizer water volume will be < 910 ft^3."

These changes are more restrictive than the existing TS; however, they are needed to ensure the adequacy of the existing LTOP relief valve setpoint of 430 psig to provide adequate LTOP protection. This section describes the staff's evaluation of these changes, as well as the continued acceptability of the LTOP enable temperature of 220 °F, which is not changed in this TS amendment.

For the reactor vessel P-T limits calculation for 32 EFPY, the licensee requested an exemption from 10 CFR Part 50, Appendix G, to allow the use of ASME Code Case N-641. The exemption request has been approved by the staff in the exemption accompanying this safety evaluation. Using the guidance of Code Case N-641, the LTOP shall be effective at coolant temperatures less than 200 °F or at coolant temperatures corresponding to a reactor vessel metal temperature less than RT_{NDT} + 50 °F for the 1/4T location, whichever is greater. Since the RT_{NDT} of the controlling beltline material is 113 °F, the LTOP effective vessel metal temperature is 163 °F, for which the corresponding coolant temperature is 186.4 °F. Per Code Case N-641, the LTOP enable temperature is 200 °F. Therefore, the existing LTOP enable temperature of 220 °F remains acceptable, with the consideration of temperature instrumentation uncertainty.

The ANO-2 LTOP system uses two redundant pressure relief valves, having an orifice area of 6.38 in^2 each, which relieve from a single discharge header on the pressurizer to prevent the reactor pressure from exceeding the P-T limits during startup or cooldown operation. The relief valves setpoint was determined by considering both mass-addition and heat-addition LTOP design basis transients, which were assumed to occur when the RCS is water solid. As described in its letter of December 21, 1999 (Reference 6), the licensee performed the LTOP transients analysis to account for the replacement steam generators. The TS vent path size of 6.38 square inches and relief valve setpoint of 430 psig were assumed in the analysis. This analysis considered two postulated limiting overpressure events: (1) the mass addition event with simultaneous injection of two HPSI pumps and all three charging pumps to a water solid RCS, and (2) the energy addition event with the start of an idle reactor coolant pump, under water solid conditions, with the secondary water temperature of the steam generator less than or equal to 100 °F above the RCS cold leg temperature. The analysis results indicated that the energy addition event was the most limiting, with the peak transient pressure being 541.2 psia. Since the peak transient pressure of 541.2 psia is still below the minimum pressure limit of 607.7 psia from the revised P-T limits in this TS amendment for 32 EFPY, the existing relief valve setpoint of 430 psig would remain acceptable.

However, during the fall 2000 refueling outage, the licensee identified a concern that flashing could occur in the relief valve discharge line for certain conditions of elevated pressurizer temperature. Flashing in the discharge line would result in higher pressure drop, and higher back pressure for the relief valves than assumed in the previous LTOP analysis. The licensee determined that the existing relief valve bellows and the operational characteristics of the LTOP valves were not sufficient for the flow rate requirements credited in the LTOP analysis without additional operational restrictions. Therefore, the licensee decided to install new relief valve bellows in the cycle 15 refueling outage, and instituted administrative controls with operating restrictions to ensure adequate overpressure protection against LTOP design basis events. These administrative controls are:

1) Operating restriction to assure two HPSI pumps are in pull-to-lock while LTOP conditions are enabled, and

2) Operating restriction to assure that the pressurizer water volume is less than 910 ft^3 when starting a reactor coolant pump.

Since the potential for higher relief valve back pressure than that assumed in the LTOP analysis would render the analysis invalid, the licensee, in Reference 5, provided a detailed analysis demonstrating how these operating restrictions compensate for the increase in the relief valve back pressure relative to the back pressure assumed in the LTOP analyses of the mass-addition and energy addition design basis events. As stated earlier, the LTOP analysis was performed with the assumptions of (1) pressurizer water solid condition, and (2) simultaneous injection of two HPSI pumps and three charging pumps. The licensee re-calculated the relief valve flow capacity based on the higher back pressure limit. With the operating restriction that two of the three HPSI pumps are in pull-to-lock while LTOP is enabled, only one HPSI would be capable of injecting into the RCS. The licensee re-calculated the total mass injecting into the RCS based on one HPSI pump injecting. The result shows the total injection rate to be less than the relief valve relief capacity at the higher back pressure limits and, therefore, the peak transient pressure would remain under the P-T limits. The proposed changes to LCO 3.4.12 to limit a maximum of one HPSI pump capable of injecting into the RCS, as well as the added Action statement (e) that, with more than one HPSI pump capable of injecting into the RCS, immediately initiate action to verify a maximum of one HPSI pump capable of injecting into the RCS, are therefore acceptable.

Also, with the operating restriction to limit the pressurizer water volume to less than 910 ft^3, a steam space is maintained in the pressurizer when a reactor coolant pump is started. This initial steam space provides a time delay before the pressurizer becomes water solid, with subsequent water insurge into the pressurizer less than the relief valve relief capacity with the higher back pressure. Therefore, the peak transient pressure would remain below the P-T limits. The proposed addition of a footnote in LCO 3.4.12 to limit the pressurizer water volume to less than 910 ft^3 ensures the existence of sufficient steam space for LTOP, and is therefore acceptable.

The TS Bases 3.4.12 are changed to reflect the proposed changes in the LCO 3.4.12, and are also acceptable.

3.2.4 Conclusions

The staff concludes that the proposed P-T limits curves for each of the pressure test, core not critical, and core critical conditions satisfy the requirements in Appendix G to Section XI of the ASME Code, as modified by Code Case N-641, and Appendix G of 10 CFR Part 50. The proposed P-T limits also satisfy GL 88-11, because the method in RG 1.99, Rev. 2, was used to calculate the ART. Hence, the proposed P-T limit curves may be incorporated into the ANO-2 TSs, and shall be valid until 32 EFPY of operation.

The staff has evaluated the reactor vessel fluence analysis and concluded that the vessel fluence values described in Reference 2 for 32 EFPY are acceptable for use in the evaluation of the PTS and P-T limits. The staff has also evaluated the proposed changes associated with the TS LCO 3.4.12 regarding LTOP system operation, and concluded that they are acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Arkansas State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (66 FR 64294, published December 12, 2001). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

7.0 REFERENCES

1. Letter from Craig Anderson, Entergy Operations, Inc., to U.S. Nuclear Regulatory Commission, "Arkansas Nuclear One - Unit 2, Docket No. 50-368, License No. NPF-6, Proposed Technical Specification Change Request Regarding Revised ANO-2 Pressure/Temperature and Low Temperature Overpressure Protection Limits for 32 Effective Full Power Years," October 30, 2001, 2CAN100101.

2. BAW-2399, "Analysis of Capsule W-104 Reactor Vessel Material Surveillance Program for ANO-Framatome ANP," September 2001.

3. BAW-2405, "Appendix G Pressure-Temperature Limits for 32 EFPY, Using ASME Code Cases for ANO-2," Framatome ANP, September 2001.

4. BAW-2241-P-A, Revision 1, "Fluence and Uncertainty Methodologies," Framatome ANP, April 1999.

5. Letter from Craig Anderson, Entergy Operations, Inc., to U.S. Nuclear Regulatory Commission, "Arkansas Nuclear One, Unit 2, Docket No. 50-368, Response to NRC Request for Additional Information on ANO-2 Low Temperature Overpressure Protection," March 13, 2002, 2CAN030201.

6. Letter from Jimmy Vandergrift, Entergy Operations, Inc., to U.S. Nuclear Regulatory Commission, "Arkansas Nuclear One - Unit 2, Docket No. 50-368, License No. NPF-6, Replacement Steam Generator Technical Specification Bases Changes," December 21, 1999, 2CAN129907.

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7590-01-P

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 2

DOCKET NO. 50-368

EXEMPTION

1.0 BACKGROUND

Entergy Operations, Inc. (the licensee) is the holder of Facility Operating License No. NPF-6 which authorizes operation of the Arkansas Nuclear One, Unit 2 (ANO-2) nuclear power plant. The license provides, among other things, that the facility is subject to all rules, regulations, and orders of the U.S. Nuclear Regulatory Commission (NRC, the Commission) now or hereafter, in effect.

The facility consists of a pressurized water reactor located in Pope County, Arkansas.

2.0 REQUEST/ACTION

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix G requires that pressure-temperature (P-T) limits be established for reactor pressure vessels (RPVs) during normal operating and hydrostatic or leak rate testing conditions. Specifically, Appendix G to 10 CFR Part 50 states that “[t]he appropriate requirements on both the pressure-temperature limits and the minimum permissible temperature must be met for all conditions.” Further, Appendix G of 10 CFR Part 50 specifies that the requirements for these limits are based on the application of evaluation procedures given in Appendix G to Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code). In this exemption, consistent with the current provisions of 10 CFR 50.55(a), all references to the ASME Code denote the 1995 Edition through the 1996 Addenda of the ASME Code.

In order to address provisions of amendments to the ANO-2 Technical Specification (TS) P-T limit curves, the licensee requested in its submittal dated October 30, 2001, that the staff exempt ANO-2 from application of specific requirements of Appendix G to 10 CFR Part 50, and substitute use of ASME Code Case N-641. ASME Code Case N-641 permits the use of an alternate reference fracture toughness curve for RPV materials and permits the postulation of a circumferentially-oriented flaw for the evaluation of circumferential RPV welds when determining the P-T limits. The proposed exemption request is consistent with, and is needed to support, the ANO-2 TS amendment that was contained in the same submittal. The proposed ANO-2 TS amendment will revise the P-T limits for heatup, cooldown, and inservice test limitations for the reactor coolant system (RCS) through 32 effective full power years of operation.

Code Case N-641

The licensee has proposed an exemption to allow use of ASME Code Case N-641 in conjunction with Appendix G to ASME Section XI, 10 CFR 50.60(a), and 10 CFR Part 50, Appendix G, to establish P-T limits for the ANO-2 RPV.

The proposed TS amendment to revise the P-T limits for ANO-2 relies in part on the requested exemption. These revised P-T limits have been developed using the lower bound K_{IC} fracture toughness curve shown in ASME Section XI, Appendix A, Figure A-2200-1, in lieu of the lower bound K_{IA} fracture toughness curve of ASME Section XI, Appendix G, Figure G-2210-1, as the basis fracture toughness curve for defining the ANO-2 P-T limits. In addition, the revised P-T limits have been developed based on the use of a postulated circumferentially-oriented flaw for the evaluation of RPV circumferential welds in lieu of the axially-oriented flaw which would be required by Appendix G to Section XI of the ASME Code.

The other margins involved with the ASME Section XI, Appendix G process of determining P-T limit curves remain unchanged.

Use of the K_{IC} curve as the basis fracture toughness curve for the development of P-T operating limits is more technically correct than use of the K_{IA} curve. The K_{IC} curve appropriately implements the use of a relationship based on static initiation fracture toughness behavior to evaluate the controlled heatup and cooldown process of a RPV, whereas the K_{IA} fracture toughness curve codified into Appendix G to Section XI of the ASME Code was developed from more conservative crack arrest and dynamic fracture toughness test data. The application of the K_{IA} fracture toughness curve was initially codified in Appendix G to Section XI of the ASME Code in 1974 to provide a conservative representation of RPV material fracture toughness. This initial conservatism was necessary due to the limited knowledge of RPV material behavior in 1974. However, additional knowledge has been gained about RPV materials which demonstrates that the lower bound on fracture toughness provided by the K_{IA} fracture toughness curve is well beyond the margin of safety required to protect the public health and safety from potential RPV failure.

Likewise, the use of a postulated circumferentially-oriented flaw in lieu of an axially-oriented one for the evaluation of a circumferential RPV weld is more technically correct. The size of flaw required to be postulated for P-T limit determination has a depth of one-quarter of the RPV wall thickness and a length six times the depth. Based on the direction of welding during the fabrication process, the only technically reasonable orientation for such a large flaw is for the plane of the flaw to be circumferentially-oriented (i.e., parallel to the direction of welding). Prior to the development of ASME Code Case N-641 (and the similar ASME Code Case N-588), the required postulation of an axially-oriented flaw for the evaluation of a circumferential RPV weld has provided an additional, unnecessary level of conservatism to the overall evaluation.

In addition, P-T limit curves based on the K_{IC} fracture toughness curve and postulation of a circumferentially-oriented flaw for the evaluation of RPV circumferential welds, will enhance overall plant safety by opening the P-T operating window with the greatest safety benefit in the region of low temperature operations. The operating window through which the operator heats up and cools down the RCS is determined by the difference between the maximum allowable pressure determined by Appendix G of ASME Section XI, and the minimum required pressure for the reactor coolant pump seals adjusted for instrument uncertainties. A narrow operating window could potentially have an adverse safety impact by increasing the possibility of inadvertant overpressure protection system actuation due to pressure surges associated with normal plant evolutions such as RCS pump starts and swapping operating charging pumps with the RCS in a water-solid condition.

Since application of ASME Code Case N-641 provides appropriate procedures to establish maximum postulated defects and evaluate those defects in the context of establishing RPV P-T limits, this application of the Code Case maintains an adequate margin of safety for protecting RPV materials from brittle failure. Therefore, the licensee concluded that these considerations were special circumstances pursuant to 10 CFR 50.12(a)(2)(ii), "[a]pplication of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule."

In summary, the ASME Section XI, Appendix G procedure was conservatively developed based on the level of knowledge existing in 1974 concerning reactor coolant pressure boundary materials and the estimated effects of operation. Since 1974, the level of knowledge about the fracture mechanics behavior of RCS materials has been greatly expanded, especially regarding the effects of radiation embrittlement and the understanding of fracture toughness properties under static and dynamic loading conditions. The NRC staff concurs that this increased knowledge permits relaxation of the ASME Section XI, Appendix G requirements by application of ASME Code Case N-641, while maintaining, pursuant to 10 CFR 50.12(a)(2)(ii), the underlying purpose of the ASME Code and the NRC regulations to ensure an acceptable margin of safety against brittle failure of the RPV.

The NRC staff has reviewed the exemption request submitted by the licensee, and has concluded that an exemption should be granted to permit the licensee to utilize the provisions of ASME Code Case N-641 for the purpose of developing ANO-2 RPV P-T limit curves.

3.0 DISCUSSION

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50 when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present.

Special circumstances, pursuant to 10 CFR 50.12(a)(2)(ii), are present in that continued operation of ANO-2 with the P-T curves developed in accordance with ASME Section XI, Appendix G without the relief provided by ASME Code Case N-641 is not necessary to achieve the underlying purpose of Appendix G to 10 CFR Part 50. Application of ASME Code Case N-641, in lieu of the requirements of ASME Code Section XI, Appendix G, provides an acceptable alternative evaluational procedure which will continue to meet the underlying purpose of Appendix G to 10 CFR Part 50. The underlying purpose of the regulations in Appendix G to 10 CFR Part 50 is to provide an acceptable margin of safety against brittle failure of the RCS during any condition of normal operation to which the pressure boundary may be subjected over its service lifetime.

The NRC staff examined the licensee’s rationale to support the exemption request, and accepts the licensee’s determination that an exemption would be required to approve the use of Code Case N-641. The staff finds that the use of ASME Code Case N-641 would meet the underlying intent of Appendix G to 10 CFR Part 50. Therefore, the NRC staff concluded that the application of the technical provisions of ASME Code Case N-641 provided sufficient margin in the development of RPV P-T limit curves such that the underlying purpose of the regulations (Appendix G to 10 CFR Part 50) continue to be met such that the specific conditions required by the regulations, i.e., use of all provisions in Appendix G to Section XI of the ASME Code, were not necessary. The NRC staff further concluded that the exemption requested by the licensee is justified based on the special circumstances of 10 CFR 50(a)(2)(ii), that "[a]pplication of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule."

Based upon a consideration of the conservatism that is explicitly incorporated into the methodologies of Appendix G to 10 CFR Part 50; Appendix G to Section XI of the ASME Code; and Regulatory Guide 1.99, Revision 2, the staff concluded that application of ASME Code Case N-641, as described, would provide an adequate margin of safety against brittle failure of the RPV. This is also consistent with the determination that the staff has reached for other licensees under similar conditions, based on the same considerations. Therefore, the staff concludes that requesting the exemption under the special circumstances of 10 CFR 50.12(a)(2)(ii) is appropriate, and that the methodology of Code Case N-641 may be used to revise the P-T limits for the ANO-2 RPV.

4.0 CONCLUSION

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), the exemption is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Also, special circumstances are present. Therefore, the Commission hereby grants Entergy Operations, Inc. an exemption from the requirements of 10 CFR 50.60 and 10 CFR Part 50, Appendix G, to allow application of ASME Code Case N-641 in establishing TS requirements for the reactor vessel pressure limits at low temperatures for ANO-2.

Pursuant to 10 CFR 51.21, 51.32, and 51.35, an environmental assessment and finding of no significant impact was published in the Federal Register on April 8, 2002 (67 FR 16769). Accordingly, based upon the environmental assessment, the Commission has determined that the granting of this exemption will not have a significant effect on the quality of the human environment.

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 15th day of April 2002.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Ledyard B. Marsh, Acting Director
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