September 12, 2005

Mr. Jeffrey S. Forbes
Site Vice President
Arkansas Nuclear One
Entergy Operations, Inc.
1448 S. R. 333
Russellville, AR 72801

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT NO. 1 - ISSUANCE OF AMENDMENT RE: USE OF M5 FUEL CLADDING AND MARK-B HIGH THERMAL PERFORMANCE FUEL (TAC NO. MC4611)

Dear Mr. Forbes:

The Commission has issued the enclosed Amendment No. 226 to Renewed Facility Operating License No. DPR-51 for Arkansas Nuclear One, Unit No. 1 (ANO-1). The amendment consists of changes to the Technical Specifications (TSs) in response to your application dated September 30, 2004, as supplemented by letter dated May 20, 2005.

The amendment revises the TSs to allow the use of M5 fuel cladding and permits the addition of the Mark-B high thermal performance fuel departure from nucleate boiling correlation, during the ANO-1 refueling Cycle 20 and beyond.

A copy of our related Safety Evaluation is also enclosed. The Notice of Issuance will be included in the Commission's next biweekly *Federal Register* notice.

Sincerely,

/RA/

Mohan C. Thadani, Senior Project Manager, Section 1
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosures: 1. Amendment No. 226 to DPR-51
2. Safety Evaluation

cc w/encls: See next page

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Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

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cc w/encls: See next page
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ENTERGY OPERATIONS INC.

DOCKET NO. 50-313

ARKANSAS NUCLEAR ONE, UNIT NO. 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 226
Renewed License No. DPR-51

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

   A. The application for amendment by Entergy Operations, Inc. (the licensee) dated September 30, 2004, as supplemented by letter dated May 20, 2005, 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 Renewed Facility Operating License No. DPR-51 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendix A, as revised through Amendment No. 226, are hereby incorporated in the renewed license. EOI 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/

David Terao, 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: September 12, 2005

ATTACHMENT TO LICENSE AMENDMENT NO. 226

RENEWED FACILITY OPERATING LICENSE NO. DPR-51

DOCKET NO. 50-313

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
2.0-1	2.0-1
4.0-2	4.0-2

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 226 TO

RENEWED FACILITY OPERATING LICENSE NO. DPR-51

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT NO. 1

DOCKET NO. 50-313

1.0 INTRODUCTION

By application dated September 30, 2004 (Agencywide Documents and Access Management System (ADAMS) Accession No. ML042880457), as supplemented by letter dated May 20, 2005 (ADAMS Accession No. ML051530305), Entergy Operations, Inc. (the licensee), requested changes to the Technical Specifications (TSs) for Arkansas Nuclear One, Unit No. 1 (ANO-1). The supplement dated May 20, 2005, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on November 9, 2004 (69 FR 64988).

The proposed changes would revise ANO-1 TS 4.2.1, “Fuel Assemblies,” to permit the use of Framatome ANP (Framatome) M5 advanced alloy for fuel rod cladding and fuel assembly structural components. The proposed amendment would also revise the ANO-1 TS 2.1.1, “Reactor Core SLs [Safety Limits],” to permit the use of the Mark-B high thermal performance (BHTP) correlation, which is needed to utilize the Framatome high thermal performance (HTP) spacer grid design. Framatome performed analyses to support co-resident fuel in mixed cores and full core of Mark-B HTP fuel to be inserted into ANO-1 during fuel Cycle 20 and beyond. The co-resident fuel includes the fresh BHTP fuel with M5 cladding and Mark-B9 fuel with zircaloy-4 cladding.

2.0 REGULATORY EVALUATION

The requested amendment entails a change to TS 4.2.1 and TS 2.1.1, which would permit the use of M5 advanced alloy fuel cladding and BHTP correlation SL, respectively. Currently, as stated in TS 4.2.1, the ANO-1 fuel cladding is zircaloy-4; therefore, an amendment is needed in order to use M5 fuel cladding. Also, ANO-1 TS 2.1.1 does not include the BHTP correlation SL; therefore, an amendment is needed in order to use the BHTP correlation.

In order to accommodate the high burnups that are required for fuel management and core designs, Framatome has developed the M5 advanced fuel rod cladding and fuel assembly structural material. M5 is an alloy comprised primarily of zirconium (~99 percent) and niobium (~1 percent). The elimination of tin in M5 has resulted in superior corrosion resistance and reduced irradiation-induced growth relative to both standard zircaloy (1.7% tin) and low-tin zircaloy (1.2% tin). The addition of niobium increases ductility, which is desirable to avoid brittle failures.

The NRC-approved Framatome Topical Report BAW-10227P-A, Revision 1, "Evaluation of Advanced Cladding and Structural Materials (M5) in PWR [Pressurized-Water Reactor] Reactor Fuel," dated June 18, 2003, describes Framatome M5 fuel and provides justification for its use in PWR cores. The licensee has stated in its submittal that operating ANO-1 with M5 in the reactor core will continue to meet the licensing limits of ANO-1. The licensee has proposed TS revisions to account for the presence of M5 fuel in the ANO-1 core.

The NRC-approved Framatome Topical Report, BAW-10241P-A, Revision 0, "BHTP DNB [Departure from Nucleate Boiling] Correlation Applied with LYNXT," dated September 29, 2004, describes the BHTP methodology for calculating the minimum DNB SL that is applied to the BHTP fuel.

The NRC staff reviewed the licensee's amendment request to ensure that operation with M5 clad fuel in the core in accordance with the proposed changes will be within the conditions of operation necessary for application of BAW-10227P-A, Revision 1, and BAW-10241P-A, Revision 0, as amended, and that the licensee will continue to operate the plant within its design basis and comply with applicable regulatory requirements following implementation of the proposed changes. These include Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.46; General Design Criteria (GDC) 4, 10, 33, 34, and 35; and Standard Review Plan (SRP) Section 4.2. The NRC staff has also approved similar submittals at plants implementing BAW-10227P-A, Revision 1. Specifically, the plants approved include Crystal River Unit 3, Oconee Units 1, 2, and 3, Davis Besse Unit 1, and Three Mile Island Unit 1. In addition, the NRC staff has approved a similar submittal at Crystal River Unit 3, which implemented a plant specific review of then BAW-10241P.

3.0 TECHNICAL EVALUATION

3.1 Addition of M5 Fuel Cladding

The license amendment request would revise the Design Features section of ANO-1 TS 4.2.1 to include the allowance to use M5 advanced alloy as a fuel rod cladding and fuel assembly structural material. Specifically, TS 4.2.1 adds two words, "or M5," such that the revised TS would read, "Each assembly shall consist of a matrix of Zircaloy or M5 clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material."

3.1.1 Analyses and Evaluations

The licensee evaluated the performance of the M5 cladding performance for both loss-of-coolant accident (LOCA) and non-LOCA scenarios. The licensee's conclusion was that the results with M5 fuel would not be substantially different from the results obtained with only zircaloy in the core. This conclusion is consistent with the conclusions in Framatome Topical

Report BAW-10227P-A, Revision 1. Based on the submittal, the NRC staff concludes that the licensee may perform reload analyses to evaluate ANO-1 operation with cores including M5 clad fuel with its present NRC-approved models adjusted to compensate for the presence of M5 clad fuel. This ensures that the licensee will continue to meet the currently applicable regulatory requirements for LOCA and non-LOCA events.

3.1.2 LOCA Analyses

Framatome ANP performed LOCA analyses to support co-resident fuel in mixed cores and full core of Mark-B-HTP fuel to be inserted into ANO-1 during fuel Cycle 20 and beyond. The co-resident fuel includes the fresh BHTP fuel with M5 cladding and Mark-B9 fuel with zircaloy-4 cladding. The full core of Mark-B HTP fuel and mixed core were analyzed using an NRC-approved evaluation model, BAW-10192P-A, "RELAP5/MOD2-B&W-Based LOCA Evaluation Model," Revision 0, and BAW-10164P-A, RELAP5/MOD2-B&W, An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis," Revision 4. However, the full core of Mark-B9 fuel was analyzed using approved BAW-10192P-A, Revision 0) and Revision 3 to BAW-10164P-A.

Because the change in inputs to consider a new fuel constitutes a significant change in the plant-specific LOCA methodologies, the licensee provided the initial ANO-1 large-break (LB) and small-break (SB) LOCA analysis results to the NRC in a supplemental letter dated May 20, 2005. These analyses were provided to confirm the conclusion that ANO-1 will meet 10 CFR 50.46(b).

The following tables provide the LBLOCA and SBLOCA analysis results:

TABLE 1 - LBLOCA

	Whole Core		Mixed Core	
	Mark-B-HTP	Mark-B9	Mark-B-HTP	Mark-B9
Peak Cladding Temperature (PCT), °F	2008	2000	1981	2000
Maximum Local Oxidation	<4%	<3.1%	<3%	<3.1%
Whole Core H_2 Generation	<0.2%	<0.3%	<0.2%	<0.3%

TABLE 2 - SBLOCA

	Mixed Core	
	Mark-B-HTP	Mark-B9
Peak Cladding Temperature (PCT), °F	1180	1180
Maximum Local Oxidation	<1%	<1%
Whole Core H_2 Generation	<0.01%	<0.01%

At the NRC staff's request, the licensee also addressed a concern that the resident fuel may have preexisting oxidation that needs to be considered in estimating the maximum local oxidation in the event of a LOCA. In its supplemental letter dated May 20, 2005, the licensee provided its response to the concern, including reference to information in the Framatome Topical Report BAW-10227P-A, Revision 1, and representative pre-LOCA oxidation values (at end of life). The staff concludes from the analysis results that the LOCA analyses for ANO-1 considered the total LOCA oxidation and meets the oxidation criterion of less than or equal to 17% of the total cladding thickness for oxidation set forth in 10 CFR 50.46(b)(2).

The NRC staff also concludes that the preexisting oxidation of the fuel is not expected to contribute to the LOCA maximum core-wide hydrogen generation. Therefore, the staff concludes that the core-wide hydrogen generation analysis results demonstrate that ANO-1 meets the core-wide hydrogen generation criterion of 10 CFR 50.46(b)(3).

As discussed above, the licensee has performed LBLOCA and SBLOCA analyses for ANO-1 using LBLOCA and SBLOCA methodologies approved for ANO-1. The licensee's LBLOCA and SBLOCA calculations demonstrated the following:

A. The calculated LBLOCA and SBLOCA values for PCT (2008 °F and 1180 °F), maximum local oxidation (<4% and <1%), and core-wide hydrogen generation (0.3% and <0.01%) are less than the limits of 2200 °F, 17%, and 1.0% specified in 10 CFR 50.46(b)(1)-(3), respectively.

B. Compliance with 10 CFR 50.46(b)(1)-(3) and (5) assures that the core will remain amenable to cooling as required by 10 CFR 50.46(b)(4). (The staff notes that no other matters that could affect coolable geometry are involved in the requested amendment.)

In summary, the staff concludes that the licensee's LOCA analyses were performed with approved LOCA methodologies that demonstrate that ANO-1 complies with the requirements of 10 CFR 50.46(b)(1)-(4). Therefore, the staff finds the licensee's LOCA analyses acceptable.

3.1.3 Non-LOCA Analyses

Framatome determined that the non-LOCA safety analyses performed using zircaloy material properties apply equally to M5 cladding. The licensee referred to Framatome Topical Report BAW-10227P-A, Revision 1, which draws the conclusion that the difference in cladding alone is not likely to substantially change the analysis results. Based on information provided by the licensee and because the material properties of M5 cladding are similar to those of zircaloy, the NRC staff has determined that this conclusion is reasonable. Therefore, it is not necessary to recalculate any of the non-LOCA safety analyses solely because the cladding material is changed to M5. As part of the regular reload process, the licensee will perform analyses of non-LOCA events for Cycle 20 using the approved methodology identified in the NRC-approved Topical Report BAW-10179P-A, “Safety Criteria and Methodology for Acceptable Cycle Reload Analysis.” Accordingly, the NRC staff concludes that the use of M5 will not substantially affect the non-LOCA analyses and, therefore, the ANO-1 licensing basis for non-LOCA events will remain the same. Therefore, the NRC staff finds that the licensee has acceptably addressed non-LOCA events.

3.2 Addition of DNB Correlation

In determining the acceptability of the licensee’s amendment request, the NRC staff reviewed BAW-10241P-A, Revision 0, which documents development of the BHTP correlation for DNB analysis of Mark-B-HTP fuel design. BAW-10241P-A, Revision 0, states that the BHTP DNB correlation limit is 1.132 for Mark-B-HTP fuel. The licensee proposed to add the 1.132 BHTP DNB limit to its TS SLs. This new correlation represents an extension of the previously approved HTP correlation, EMF-92-153-P-A, "HTP: Departure from Nucleate Boiling Correlation for High Thermal Performance Fuel." The primary difference between the BHTP and HTP correlations is the use of the LYNXT and XCOBRA-IIIC codes, respectively, for critical heat flux (CHF) data reduction. The codes vary in their treatment of water properties.

The BHTP DNB correlation is an empirically derived function of the local coolant thermodynamic state and mass flux at which DNB is observed to occur in the experiment. Framatome developed the base correlation from local coolant conditions at the point of DNB, as predicted from test data for the uniform axial power distribution. The local coolant conditions are calculated with the approved LYNXT computer code, BAW-10156P-A, "LYNXT-Core Transient Thermal-Hydraulic Program." Framatome modified the predicted DNB heat flux to account for the effect of non-uniform axial power distribution and fuel assembly design parameters. This aspect is the same as the formulation used in the approved HTP DNB correlation.

For a specific core, the ability of the fuel assembly to remain below the threshold of DNB is primarily related to the mechanical configuration of the fuel assembly rather than the type of cladding material used. M5 and zircaloy-4 have very similar heat transfer properties. Although the correlation is developed for the zircaloy-4 cladding fuel assembly, the licensee contended that the BHTP DNB correlation is equally applied to the Mark-B-HTP fuel assembly with M5 cladding. The staff examined the M5 cladding properties in the approved BAW-10227P-A, Revision 1, and found the licensee’s assessment acceptable.

The NRC staff reviewed the effects of the proposed changes using the appropriate requirements of GDC 10, SRP sections 4.2, 4.3, and 4.4, and 10 CFR 50.46. The NRC staff

found that the licensee's amendment request provided reasonable assurance that, under both normal and accident conditions, the licensee would be able to safely operate the plant and comply with the NRC regulations. Therefore, the NRC staff finds that the licensee's amendment request is acceptable.

The NRC staff concludes that it is acceptable to operate ANO-1 with M5 fuel and use the BHTP DNB correlation, as long as operation is within the bounds of the analyses performed with the specific methodologies applicable to ANO-1, as stated in this Safety Evaluation and as specified in the licensee's TS and Final Safety Analysis Report. The NRC staff concludes that it is acceptable to operate ANO-1 with the M5 fuel and BHTP DNB correlation as proposed because it is technically justified, as discussed above, and because appropriate TS control is provided. This Safety Evaluation provides the basis for operation of ANO-1 with its core partially or fully loaded with M5 fuel assemblies. On the same basis, the NRC staff also concludes that use of fuel assembly structural components made of M5 is acceptable for ANO-1 operation.

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 amendments involve no significant hazards consideration, and there has been no public comment on such finding published November 9, 2004 (69 FR 64988). 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.

Principal Contributor: S. Wu

Date: September 12, 2005
Arkansas Nuclear One

cc:

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