

March 19, 2008

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

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 2 - EXEMPTION FROM REQUIREMENTS
OF 10 CFR SECTION 50.46 AND APPENDIX K TO 10 CFR PART 50, TO
ALLOW USE OF OPTIMIZED ZIRLO™ AS FUEL ROD CLADDING MATERIAL
(TAC NO. MD5378)

Dear Sir or Madam:

The Commission has approved the enclosed exemption from specific requirements of Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.46, "Acceptance criteria for emergency core cooling systems [ECCS] for light-water nuclear power reactors," and Appendix K to 10 CFR Part 50, "ECCS Evaluation Models," for the Arkansas Nuclear One, Unit 2. This action is in response to your application for an exemption dated April 24, 2007, to allow the use of Optimized ZIRLO™ for fuel rod cladding.

A copy of the exemption is enclosed. The exemption has been forwarded to the Office of the Federal Register for publication.

Sincerely,

/RA/

Alan B. Wang, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-368

Enclosure:
Exemption

cc w/encl: See next page

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ADAMS Accession No.: ML080370012

(*) See previous concurrence

OFFICE	NRR/LPL4/PM	NRR/LPL4/LA	NRR/LPL4/BC	NRR/DORL/D	OGC – no legal objection	NRR/DORL/D [sign]
NAME	AWang (*)	JBurkhardt (*)	THiltz, CFL for	CHaney	MSpencer (*)	CHaney
DATE	2/22/08	2/21/08	3/18/08	3/19/08	3/12/08	3/19/08

OFFICIAL RECORD COPY

Arkansas Nuclear One

(2/25/2008)

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ENCLOSURE

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 2

EXEMPTION

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

The facility consists of a pressurized-water reactor (PWR) located in Pope County, Arkansas.

2.0 REQUEST/ACTION

Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," requires, among other items, that "[e]ach boiling or pressurized light-water nuclear power reactor fueled with uranium oxide pellets within cylindrical zircaloy or ZIRLO cladding must be provided with an emergency core cooling system (ECCS) that must be designed so that its calculated cooling performance following postulated loss-of-coolant accidents [(LOCAs)] conforms to the criteria set forth in paragraph (b) of this section." Appendix K to 10 CFR Part 50, "ECCS Evaluation Models," requires, among other items, that the rate of energy release, hydrogen generation, and cladding oxidation from the metal/water reaction shall be calculated using the Baker-Just

equation. The regulations of 10 CFR 50.46 and 10 CFR Part 50, Appendix K, make no provision for use of fuel rods clad in a material other than zircaloy or ZIRLO. Since the chemical composition of the Optimized ZIRLO™ alloy differs from the specifications for zircaloy or ZIRLO, a plant-specific exemption is required to allow the use of the Optimized ZIRLO™ alloy as a cladding material at ANO-2. Therefore, by letter dated April 24, 2007, the licensee requested the use of the Optimized ZIRLO™ for fuel rod cladding at ANO-2.

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.

Authorized by Law

This exemption results in changes to the operation of the plant by allowing the use of the Optimized ZIRLO™ as fuel rod cladding material in lieu of zircaloy or ZIRLO. As stated above, 10 CFR 50.12 allows the NRC to grant exemptions from the requirements of 10 CFR Part 50. The NRC staff has determined that granting of the licensee's proposed exemption will not result in a violation of the Atomic Energy Act of 1954, as amended, or the Commission's regulations. Therefore, the exemption is authorized by law.

No Undue Risk to Public Health and Safety

By letter dated June 10, 2005, the NRC staff approved Westinghouse Topical Report WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML051670408). The NRC staff approved the use of Optimized ZIRLO™ as a fuel cladding material based on: 1) similarities with standard ZIRLO™, 2) demonstrated material performance, and 3) a

commitment to provide irradiated data and validate fuel performance models ahead of burnups achieved in batch application. The NRC staff's safety evaluation for Optimized ZIRLO™ includes 10 conditions and limitations for its use. In addition, the NRC's June 10, 2005, safety evaluation for Optimized ZIRLO™ recommends that the computer codes used to perform fuel design safety analyses incorporate the material properties of Optimized ZIRLO™.

The underlying purpose of 10 CFR 50.46 is to establish acceptance criteria for ECCS performance. The applicability of these ECCS acceptance criteria has been demonstrated by Westinghouse. Ring compression tests performed by Westinghouse on Optimized ZIRLO™ (documented in Appendix B of WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A "Optimized ZIRLO™," July 2006, ADAMS Accession No. ML062080576) demonstrate an acceptable retention of post-quench ductility up to 2200 degrees Fahrenheit [°F] and 17 percent equivalent clad reacted 10 CFR 50.46 limits. Furthermore, oxidation measurements provided by the licensee (by letter dated November 6, 2007, "SER [Safety Evaluation Report] Compliance with WCAP-12610-P-A & CENPD-404-P-A Addendum 1-A 'Optimized ZIRLO™'," LTR-NRC-07-58, ADAMS Accession No. ML073130562), illustrate that oxide thickness (and associated hydrogen pickup) for Optimized ZIRLO™ at any given burnup would be less than both Zircaloy-4 and ZIRLO™. Hence, Optimized ZIRLO™ would be expected to maintain better post-quench ductility. This finding is based on an ongoing LOCA research program at Argonne National Laboratory which has identified a strong correlation between cladding hydrogen content (due to in-service corrosion) and post-quench ductility.

Utilizing currently approved LOCA models and methods, Westinghouse performed a plant-specific evaluation and found that the Optimized ZIRLO™ fuel rods will satisfy the 10 CFR 50.46 acceptance criteria. Therefore, the exemption request continues to ensure that the underlying purpose of the rule is achieved.

Paragraph I.A.5 of Appendix K to 10 CFR Part 50 states that the rates of energy, hydrogen concentration, and cladding oxidation from the metal-water reaction shall be calculated using the Baker-Just equation. Since the Baker-Just equation presumes the use of zircaloy clad fuel, strict application of the rule would not permit use of the equation for Optimized ZIRLO™ cladding for determining acceptable fuel performance. Metal-water reaction tests performed by Westinghouse on Optimized ZIRLO™ (documented in Appendix B of WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A) demonstrate conservative reaction rates relative to the Baker-Just equation. Thus, a prohibition on the use of Optimized ZIRLO™ is not necessary for the licensee to achieve the underlying purpose of paragraph I.A.5 of Appendix K in these circumstances.

Based on the above, no new accident precursors are created by using Optimized ZIRLO™, thus, the probability of postulated accidents is not increased. Also, based on the above, the consequences of postulated accidents are not increased. In addition, the licensee will use NRC-approved methods for the reload design process for ANO-2 reloads with Optimized ZIRLO™. Therefore, there is no undue risk to public health and safety due to using Optimized ZIRLO™.

Special Circumstances

Special circumstances, in accordance with 10 CFR 50.12(a)(2)(ii), are present whenever application 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 this circumstance, neither 10 CFR 50.46 nor 10 CFR Part 50, Appendix K, explicitly allows the use of Optimized ZIRLO™ as a fuel rod cladding material.

The underlying purpose of 10 CFR 50.46 is to ensure that facilities have adequate acceptance criteria for the ECCS. Based upon results of metal-water reaction tests and ring-compression tests which ensure the applicability of ECCS models and acceptance criteria

and the use of approved LOCA models to ensure compliance to 10 CFR 50.46 acceptance criteria, the staff finds it acceptable to grant an exemption from the 10 CFR 50.46 and Appendix K to 10 CFR Part 50 to allow the use of Optimized ZIRLO™ in future reloads at ANO-2.

On June 10, 2005, the NRC staff approved WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, in which Westinghouse demonstrated that the effectiveness of the ECCS will not be affected by a change from zircaloy to Optimized ZIRLO™. The analysis described in the WCAP-12610-P-A and CENPD-404-P-A also demonstrated that the ECCS acceptance criteria applied to reactors fueled with zircaloy fuel rod cladding are also applicable to reactors fueled with Optimized ZIRLO™ WCAP-12610-P-A and CENPD-404-P-A fuel rod cladding.

The underlying purpose of 10 CFR Part 50, Appendix K, paragraph I.A.5, is to ensure that cladding oxidation and hydrogen generation are appropriately limited during a LOCA and conservatively accounted for in the ECCS evaluation model. Appendix K to 10 CFR Part 50 requires that the Baker-Just equation be used in the ECCS evaluation model to determine the rate of energy release, cladding oxidation, and hydrogen generation. In WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, Westinghouse demonstrated that the Baker-Just model is conservative in all post-LOCA scenarios with respect to the use of the Optimized ZIRLO™ as a fuel rod cladding material, and that the amount of hydrogen generated in an Optimized ZIRLO™ core during a LOCA will remain within the ANO-2 design basis.

Optimized ZIRLO™ is a niobium-tin-iron (Nb-Sn-Fe) zirconium (Zr) based alloy with a microstructure comprised of a body-centered cubic ZrNb phase and a close-packed hexagonal ZrNbFe phase homogeneously distributed throughout the zirconium matrix. Optimized ZIRLO™ fuel cladding is different from standard ZIRLO™ in two respects: 1) the Sn content is lower, and 2) the microstructure is different. This difference in Sn content and microstructure can lead to differences in some material properties. Most of the material properties of standard ZIRLO™

and Optimized ZIRLO™ are the same within the uncertainty of the data and, therefore, use of standard ZIRLO™ properties for safety analyses is acceptable. The NRC staff has reviewed the licensee's request to use Optimized ZIRLO™ for PWR fuel mechanical designs as described in WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A. In the June 10, 2005, safety evaluation for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, the NRC staff concluded that, to the extent specified in the NRC staff's evaluation, the Optimized ZIRLO™ properties and mechanical design methodology are acceptable for referencing in fuel reload licensing applications. Therefore, since the underlying purposes of 10 CFR 50.46 and 10 CFR Part 50, Appendix K, paragraph I.A.5 are achieved through the use of the Optimized ZIRLO™ as a fuel rod cladding material, the special circumstances required by 10 CFR 50.12(a)(2)(ii) for the granting of an exemption from 10 CFR 50.46 and Appendix K to 10 CFR Part 50, exist.

Summary

The NRC staff has reviewed the licensee's request to use the Optimized ZIRLO™ for fuel rod cladding in lieu of zircaloy or ZIRLO. Based on the NRC staff's evaluation, as set forth above, the NRC staff concludes that the exemption is authorized by law, will not present an undue risk to public health and safety, and is consistent with the common defense and security. In addition, the NRC staff concludes that the underlying purposes of 10 CFR 50.46 and Appendix K to 10 CFR Part 50, are achieved through the use of the Optimized ZIRLO™ alloy. Therefore, pursuant to 10 CFR 50.12(a), the NRC staff concludes that the use of the Optimized ZIRLO™ alloy for fuel rod cladding is acceptable and the exemption from 10 CFR 50.46 and Appendix K to 10 CFR Part 50, is justified. Although the use of Optimized ZIRLO™ is allowed, the other requirements of 10 CFR 50.46 and Appendix K to 10 CFR Part 50 apply to the use of Optimized ZIRLO™. The conditions and limitations on the use of Optimized ZIRLO™ will be discussed in the staff's action on the license amendment request submitted by the applicant dated April 24, 2007.

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 an exemption from the requirements of 10 CFR 50.46 and Appendix K to 10 CFR Part 50, for ANO-2.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not have a significant impact on the quality of the human environment as published in the *Federal Register* on March 10, 2008 (73 FR 12779). This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 19 day of March 2008.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Catherine Haney, Director
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation