

**NUCLEAR REGULATORY COMMISSION**

**[NRC-2010-0281]**

**Arizona Public Service Company, et al.**

**Palo Verde Nuclear Generating Station, Unit 3**

**Docket No. STN 50-530**

**Temporary Exemption**

**1.0 BACKGROUND**

Arizona Public Service Company (APS, the licensee) is the holder of Facility Operating License No. NPF-74, which authorizes operation of the Palo Verde Nuclear Generating Station (PVNGS), Unit 3. 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 located in Maricopa County, Arizona.

**2.0 REQUEST/ACTION**

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.12, "Specific exemptions," APS has, by letter dated November 2, 2009, and supplemented by letter dated May 12, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML093160596 and ML101410262, respectively), requested a temporary exemption from 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," and Appendix K to 10 CFR Part 50, "ECCS Evaluation Models," (Appendix K). The regulations in 10 CFR 50.46 contain acceptance criteria for the

emergency core cooling system (ECCS) for reactors fueled with zircaloy or ZIRLO cladding. In addition, Appendix K to 10 CFR Part 50 requires that the Baker-Just equation be used to predict the rates of energy release, hydrogen concentration, and cladding oxidation from the metal-water reaction. The temporary exemption request relates solely to the specific types of cladding material specified in these regulations. As written, the regulations presume the use of zircaloy or ZIRLO fuel rod cladding. Thus, an exemption from the requirements of 10 CFR 50.46 and Appendix K is needed to irradiate lead fuel assemblies (LFAs) comprised of different cladding alloys at PVNGS, Unit 3.

The temporary exemption requested by the licensee would allow up to eight LFAs manufactured by Westinghouse Electric Company LLC (Westinghouse) with fuel rods clad with Optimized ZIRLO™ to be inserted into the PVNGS, Unit 3, core during the fall 2010 refueling outage. The temporary exemption would allow the LFAs to be used for up to three operating cycles (Cycles 16, 17, and 18).

### **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. Under 10 CFR 50.12(a)(2), special circumstances include, among other things, when application of the specific regulation in the particular circumstance would not serve, or is not necessary to achieve, the underlying purpose of the rule.

### **Authorized by Law**

This exemption would allow up to eight LFAs with Optimized ZIRLO™ cladding to be inserted into the PVNGS, Unit 3 reactor core during the fall 2010 refueling outage. It would also allow the LFAs to be used for up to three operating cycles (Cycles 16, 17, and 18). The Optimized ZIRLO™ cladding is of a slightly different material composition than the zircaloy or ZIRLO cladding explicitly identified in 10 CFR 50.46, and implicitly assumed in 10 CFR Part 50, Appendix K, for light water reactor fuel. However, the fundamental requirements regarding ECCS performance can still be satisfied by the LFAs with the Optimized ZIRLO™ cladding. 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**

The underlying purpose of 10 CFR 50.46 is to establish acceptance criteria for ECCS performance. Westinghouse topical reports WCAP-16500-P-A, Revision 0, "CE [Combustion Engineering] 16x16 Next Generation Fuel Core Reference Report," dated August 2007, and WCAP-12610-P-A & CENPD-404-P-A, "Optimized ZIRLO™," dated July 2006, contain the justification to use Optimized ZIRLO™ as a fuel cladding material in addition to Zircaloy-4 and ZIRLO (these topical reports are non-publicly available because they contain proprietary information). The NRC staff approved the use of these topical reports, subject to the conditions stated in the staff's safety evaluations for each. In these topical reports, Westinghouse

evaluated the structural and material properties of Optimized ZIRLO™ and determined that the use of Optimized ZIRLO™ as cladding would have either no significant impact or would produce a reduction in corrosion or oxidation and a corresponding reduction in hydrogen pickup.

Westinghouse also evaluated the impact of Optimized ZIRLO™ fuel cladding on the LOCA and non-LOCA accident analyses. The evaluations determined that the LOCA analyses for fuel with Optimized ZIRLO™ cladding complied with 10 CFR 50.46, and that there was a negligible difference in the non-LOCA analyses between fuel clad with standard ZIRLO and fuel clad with Optimized ZIRLO™.

The underlying purpose of 10 CFR Part 50, Appendix K, Section I.A.5, "Metal-Water Reaction Rate," 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 of 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. Westinghouse has shown in WCAP-12610-P-A that the Baker-Just model is conservative in all post-LOCA scenarios with respect to the use of the Optimized ZIRLO™ advanced alloy as a fuel cladding material.

In its exemption request dated November 2, 2009, APS commits to evaluate the performance of the Next Generation Fuel (NGF) LFAs with Optimized ZIRLO™ cladding with respect to the PVNGS safety analyses. The analyses to be performed as part of that evaluation, which the licensee commits to being due October 30, 2010, shall include thermal hydraulic compatibility, loss-of-coolant accident (LOCA) and non-LOCA criteria, mechanical design, thermal hydraulics, seismic, core physics, and neutronic capability of the NGF LFAs in the PVNGS, Unit 3 reactor core. The thermal-hydraulic compatibility analyses for the LFAs shall include evaluations of departure from nucleate boiling (DNB) performance, guide tube heating,

core bypass flow, fuel centerline melt, rod bow, and LOCA. The neutronic compatibility evaluation will compare design characteristics of the LFAs to co-resident fuel to ensure compatibility. Furthermore, APS commits to having a compatibility study performed to ensure that insertion of the LFAs will not cause the remaining Westinghouse fuel to exceed its operating limits and ensure there is no adverse impact on the fuel performance or mechanical integrity. In order to ensure compatibility, the study shall include detailed evaluations in several functional areas, such as structural/seismic analyses, ECCS performance, LOCA dose assessment, thermal hydraulics, and mechanical design. In addition, the evaluations will determine the impact on the analyses of record, if any. The licensee commits to a due date of October 30, 2010, for the compatibility study. In addition, the licensee commits to poolside examinations of the ongoing assembly and cladding performance as detailed in the "Commitments, Conditions, and Limitations" section below.

APS shall place the LFAs in non-limiting power locations where the predicted peak pin power is less than or equal to 0.95 of the predicted cycle maximum peak pin power in the core. Therefore, the LFAs will not contain the lead rod in the core and will have margin relative to cycle maximum peak power. Since the LFAs will not be in the highest core power density locations, their operation will be bounded by the safety analyses performed for the existing fuel assemblies. Additionally, the maximum LFA integrated fuel rod burnup shall be maintained less than or equal to 60 gigawatt days per metric ton uranium.

The PVNGS, Unit 3, temporary exemption request relates solely to the specific types of cladding material specified in the regulations. No new or altered design limits for purposes of 10 CFR Part 50, Appendix A, General Design Criterion 10, "Reactor Design," need to be applied or are required for this exemption.

Based on the use of approved models and methods, expected material performance, and the placement of the LFAs in non-limiting core locations, the NRC staff concludes that the irradiation of up to eight LFAs in the PVNGS, Unit 3, core will not result in unsafe operation or violation of specified acceptable fuel design limits. Furthermore, in the event of a design-basis accident, these LFAs will not cause consequences beyond those previously analyzed. Based upon results from experimental data using Optimized ZIRLO™ cladding for its cooling performance, and the results of the calculations of rate of energy release, hydrogen generation, and cladding oxidation from the metal-water reaction, which ensure the applicability of ECCS models and acceptance criteria, and the use of approved LOCA evaluation models to ensure that LFAs satisfy 10 CFR 50.46 acceptance criteria, the NRC staff considers the LFAs acceptable for use in the PVNGS, Unit 3, core as proposed, subject to the additional commitments made by APS.

Based on the above, no new accident precursors are created by allowing the use of the LFAs with Optimized ZIRLO™ cladding material in the PVNGS, Unit 3, core during Operating Cycles 16, 17, and 18. Also, based on the above, the consequences of postulated accidents are not increased. Therefore, there is no undue risk to public health and safety in granting this temporary exemption.

### **Consistent with Common Defense and Security**

The proposed exemption would allow the use of up to 8 LFAs with advanced cladding material. This change to the plant has no relation to security issues. Therefore, the common defense and security is not impacted by this exemption.

### **Special Circumstances**

Special circumstances, in accordance with 10 CFR 50.12(a)(2)(ii), are present whenever application of the specific regulation in the particular circumstance would not serve, or is not necessary to achieve, the underlying purpose of the rule. The underlying purpose of 10 CFR 50.46 and Appendix K to 10 CFR Part 50 is to establish acceptance criteria for ECCS performance. The wording of the regulations in 10 CFR 50.46 and Appendix K is not directly applicable to Optimized ZIRLO™ cladding, even though the evaluations above show that the intent of the regulations is met. Therefore, since the underlying purpose of 10 CFR 50.46 and Appendix K is achieved with the use of the Optimized ZIRLO™ cladding, the special circumstances required by 10 CFR 50.12(a)(2)(ii) for the granting of an exemption exist.

### **Commitments, Conditions, and Limitations**

In its letter dated November 2, 2009, the licensee made the following regulatory commitments:

1. Prior to startup for Unit 3 Cycle 17, poolside examinations will be performed to evaluate ongoing assembly and cladding performance. (Due 4/30/2012)
2. Prior to startup for Unit 3 Cycle 18, poolside examinations will be performed to evaluate ongoing assembly and cladding performance. (Due 10/30/2013)
3. After completion of Unit 3 Cycle 18 (the third and final irradiation cycle), poolside examinations will be performed to evaluate assembly and cladding performance. (Due 6/30/2015)

4. The Westinghouse NGF LFAs will be modeled in the PVNGS core physics models, including the Zirconium di-boride integral fuel burnable absorber (IFBA). As such, the impact of the LFAs will be included in the PVNGS cycle-specific core physics calculations supporting the reload effort for each cycle during use of the LFAs. (Due 10/30/2010, 4/30/2012, and 10/30/2013, respectively)
5. Evaluations will verify performance of the Westinghouse NGF LFAs with respect to the safety analysis. The analyses will include thermal-hydraulic compatibility, loss-of-coolant accident (LOCA) and non-LOCA criteria, mechanical design, thermal hydraulic, seismic, core physics, and neutronic compatibility of the LFAs in the PVNGS Unit 3 core. The evaluations will make use of the fact that the LFAs will be operated in non-limiting locations and will verify the reload analyses are not adversely impacted. The results will be documented in a final design report. (Due 10/30/2010)
6. A compatibility study will be performed to ensure that insertion of the Westinghouse NGF LFAs will not cause the remaining Westinghouse fuel to exceed its operating limits and ensure there is no adverse impact on fuel performance or mechanical integrity. The results of the compatibility study will be documented in a final design report. (due 10/30/2010)

In addition, since APS referenced Westinghouse Topical Report WCAP-12610-P-A & CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," dated July 2006, in its request for the exemption to use LFAs with Optimized ZIRLO™ cladding, the licensee shall ensure compliance with the conditions and limitations listed in Section 5.0 of the NRC staff's Safety Evaluation Report for that report.



#### 4.0 CONCLUSION

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12, 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 APS a temporary exemption from the requirements of 10 CFR 50.46 and Appendix K to allow the use of fuel rods clad with an advanced alloy, Optimized ZIRLO™, in the PVNGS, Unit 3, core in non-limiting locations during Operating Cycles 16, 17, and 18.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not have a significant effect on the quality of the human environment as published in the *Federal Register* on August 24, 2010 (75 FR 52045).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 26<sup>th</sup> day of August 2010.

FOR THE NUCLEAR REGULATORY COMMISSION

**/RA/**

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