

# **NUCLEAR REGULATORY COMMISSION**

**Docket Nos. STN 50-528, STN 50-529, and STN 50-530**

**Arizona Public Service Company**

**Palo Verde Nuclear Generating Station, Units 1, 2, and 3**

## **Exemption**

### **I. Background**

Arizona Public Service Company (APS, the licensee) is the holder of Renewed Facility Operating License Nos. NPF-41, NPF-51, and NPF-74, which authorizes operation of Palo Verde Nuclear Generating Station, Units 1, 2, and 3 (Palo Verde), respectively. 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) now or hereafter in effect. The facility consists of a pressurized-water reactor (PWR) located in Maricopa County, Arizona.

By application dated July 6, 2018, as supplemented by letters dated October 18, 2018; March 1, 2019; May 17, 2019; October 4, 2019; November 26, 2019; and December 19, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML18187A417, ML18296A466, ML19060A298, ML19137A118, ML19277J457, ML19331A361, and ML19353C038, respectively), APS, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.12, "Specific exemptions," requested an exemption from certain requirements of 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems [ECCS] for light-water nuclear power reactors," and 10 CFR Part 50, Appendix K, "ECCS Evaluation Models," for Palo Verde. Since these regulations specifically refer only to zircaloy and ZIRLO™, an exemption would be required to apply them to fuel clad with other materials, such as Framatome M5® zirconium alloy.<sup>1</sup> Therefore, APS has requested such an exemption to

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<sup>1</sup> HTP and M5® are trademarks or registered trademarks of Framatome, Inc. (formerly AREVA Inc.).

support transition to the Framatome M5<sup>®</sup> alloy cladding. The proposed request would not exempt Palo Verde from the requirements of 10 CFR 50.46 or 10 CFR Part 50, Appendix K regarding acceptance criteria, evaluation model features and documentation, reporting of changes or errors, etc.

The submittal from APS described above also contains the fuel transition license amendment request that is necessary to support batch loading of Framatome Advanced Combustion Engineering (CE) 16x16 High Thermal Performance (HTP<sup>™</sup>) fuel. This exemption is specific to the Framatome M5<sup>®</sup> cladding material exemption request only. The fuel transition and associated technical specification changes are subject to a concurrent review that is being documented in the safety evaluation (SE) with the license amendments (ADAMS Accession No. ML20031C947).

Precedent exemptions have also been approved for other CE plants including St. Lucie Plant, Unit Nos. 1 and 2 (ADAMS Accession Nos. ML14064A125 and ML16015A286, respectively).

## **II. Request/Action**

By application dated July 6, 2018, as supplemented by letters dated October 18, 2018, and March 1, 2019; May 17, 2019; October 4, 2019; November 26, 2019; and December 19, 2019, APS, pursuant to 10 CFR 50.12, requested an exemption from the requirements of 10 CFR 50.46 and Appendix K to 10 CFR Part 50. The proposed exemption request would permit the application of 10 CFR 50.46 and Appendix K to 10 CFR Part 50 to fuel rods clad with Framatome M5<sup>®</sup> alloy at Palo Verde. Since the requirements in 10 CFR 50.46 and Appendix K to 10 CFR Part 50 are predicated upon the use of fuel clad with zircaloy or ZIRLO<sup>™</sup> alloy, an exemption is necessary to apply these requirements to fuel rods clad with Framatome M5<sup>®</sup> alloy.

The technical basis supporting the use of fuel clad with M5® in PWRs is documented primarily in Topical Report BAW-10227-P-A, Revision 1, "Evaluation of Advanced Cladding and Structural Material (M5®) in PWR Reactor Fuel," dated June 2003 (ADAMS Accession No. ML15162B043). This topical report describes Framatome's evaluation supporting the use of the M5® alloy in PWR fuel assemblies as a replacement for Zircaloy-4. This topical report discusses fundamental material properties of M5®, as well as its behavior under normal operation, anticipated transients, and postulated accident conditions.

### **III. Discussion**

The regulation in Section 50.46(a)(1)(i) of 10 CFR states, in part:

Each 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 conforms to the criteria set forth in paragraph (b) of this section. ECCS cooling performance must be calculated in accordance with an acceptable evaluation model and must be calculated for a number of postulated loss-of-coolant accidents of different sizes, locations, and other properties sufficient to provide assurance that the most severe postulated loss-of-coolant accidents are calculated.

Since 10 CFR 50.46 specifically refers to fuel with zircaloy or ZIRLO™ cladding, its application to fuel clad with materials other than zircaloy or ZIRLO™ requires an exemption from this section of the regulations.

The regulation in paragraph I.A.5, "Metal – Water Reaction Rate," of 10 CFR Part 50, Appendix K, states, in part:

The rate of energy release, hydrogen generation, and cladding oxidation from the metal/water reaction shall be calculated using the Baker-Just equation (Baker, L., Just, L.C., "Studies of Metal Water Reactions at High Temperatures, III. Experimental and Theoretical Studies of the Zirconium-Water Reaction," ANL-6548, page 7, May 1962).

The requirement for using the Baker-Just equation in Appendix K-conformant loss-of-coolant accident evaluation models presumes use of zircaloy or ZIRLO™ clad fuel rods.

Therefore, application of 10 CFR Part 50, Appendix K to cladding materials other than zircaloy or ZIRLO™ also requires an exemption.

The exemption request from APS relates solely to the particular types of fuel cladding materials specified in these regulations. As written, the regulations presume use of zircaloy or ZIRLO™ cladding. Thus, an exemption is necessary to apply 10 CFR 50.46 and 10 CFR Part 50, Appendix K to other cladding materials such as M5®. The proposed request would not exempt Palo Verde from any other requirements of 10 CFR 50.46 or 10 CFR Part 50, Appendix K regarding acceptance criteria, evaluation model features and documentation, reporting of changes or errors, etc.

Section 50.12 of 10 CFR states that the Commission may grant exemptions from requirements of the regulations in 10 CFR Part 50 for reasons, which are (1) the exemption is authorized by law, (2) the exemption will not present an undue risk to the public health and safety, (3) the exemption is consistent with the common defense and security, and (4) special circumstances, as defined in 10 CFR 50.12(a)(2), are present. The licensee's submittal identifies in particular that the special circumstance associated with this exemption request is that restricting application of 10 CFR 50.46 and 10 CFR Part 50, Appendix K to fuels clad with only zircaloy or ZIRLO™ is not necessary to achieve the underlying purpose of these regulations.

**A. The Exemption is Authorized by Law**

The NRC has the authority under 10 CFR 50.12 to grant exemptions from the requirements of Part 50 upon demonstration of proper justification. The fuel that will be irradiated at Palo Verde is clad with a zirconium-based alloy that is not expressly within the scope of 10 CFR 50.46 and 10 CFR Part 50, Appendix K. However, the NRC staff considers the acceptance criteria and methods of these regulations applicable to M5®, and the licensee will ensure that these regulations are satisfied for operation with fuel clad with M5®. Therefore, the exemption is authorized by law.

**B. The Exemption Presents no Undue Risk to Public Health and Safety**

The NRC-approved Topical Report BAW-10227-P-A, which concerns the properties of the M5<sup>®</sup> alloy, provides assurance that predicted chemical, thermal, and mechanical characteristics of M5<sup>®</sup> alloy cladding are acceptable under normal operation, anticipated transients, and postulated accidents. The NRC staff further found that the acceptance criteria and analytical methods from 10 CFR 50.46 and 10 CFR Part 50, Appendix K provide acceptable safety margins for fuel clad with M5<sup>®</sup> that are consistent with those the NRC has established for zircaloy and ZIRLO<sup>™</sup>. Reload cores involving M5<sup>®</sup> cladding will continue to be subject to the operating limits specified in the technical specifications and core operating limits report. Thus, granting this exemption request will not pose undue risk to public health and safety.

**C. The Exemption is Consistent with the Common Defense and Security**

The proposed exemption will allow the licensee to use an enhanced fuel rod cladding material relative to the zircaloy material for which the requirements of 10 CFR 50.46 and 10 CFR Part 50, Appendix K were originally established. In addition to its review of the exemption request described in this SE, the NRC staff has further evaluated all licensing-basis changes necessary to support loading fuel clad with M5<sup>®</sup> in a separate SE and documented the basis for their acceptability. Based on these reviews, the NRC staff concludes that the use of M5<sup>®</sup> fuel rod cladding at Palo Verde will not significantly affect plant operations and is therefore consistent with the common defense and security.

**D. Special Circumstances**

Neither 10 CFR 50.46 nor 10 CFR Part 50, Appendix K explicitly applies to fuel clad with M5<sup>®</sup>. However, the underlying purpose of 10 CFR 50.46 and 10 CFR Part 50, Appendix K is to provide requirements capable of ensuring adequate core cooling following the most limiting postulated loss-of-coolant accident. As discussed above, Framatome has demonstrated in an NRC-approved topical report (i.e., BAW-10227-P-A) that application of the acceptance criteria

and analytical methods required in 10 CFR 50.46 and 10 CFR Part 50, Appendix K to fuel clad with M5® is acceptable. Normal core reload safety analyses will further confirm on a cycle-specific basis that there is no adverse impact on ECCS performance for Palo Verde. Therefore, strict application of the material-specific requirements for fuel cladding in 10 CFR 50.46 and 10 CFR Part 50, Appendix K is not necessary to achieve the underlying purpose of ensuring adequate core cooling in this instance. Furthermore, granting an exemption to allow application of the balance of these regulations to fuel clad with M5® at Palo Verde would be consistent with the underlying regulatory purpose.

**E. Supplemental Information**

For more technical details, refer to the SE associated with this exemption under ADAMS Accession No. ML20022A109 (Enclosure 2).

**F. Environmental Considerations**

The NRC staff determined that the exemption discussed herein meets the eligibility criteria for the categorical exclusion set forth in 10 CFR 51.22(c)(9) because it is related to a requirement concerning the installation or use of facility components located within the restricted area, as defined in 10 CFR Part 20, and the granting of this exemption involves: (i) no significant hazards consideration, (ii) no significant change in the types or a significant increase in the amounts of any effluents that may be released offsite, and (iii) no significant increase in individual or cumulative occupational radiation exposure. Therefore, in accordance with 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the NRC's consideration of this exemption request.

**IV. Conclusions**

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 an exemption from the requirements of 10 CFR 50.46 and 10 CFR Part 50, Appendix K, to allow the use of Framatome M5<sup>®</sup> alloy fuel rod cladding material at Palo Verde, Units 1, 2, and 3. As stated above, this exemption relates solely to the cladding material specified in these regulations.

Dated at Rockville, Maryland, this 4th day of March 2020.

For the Nuclear Regulatory Commission.

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